TECHNICAL SPECIFICATIONS PACKAGE
FOR
CSO VARIOUS PROJECTS, GROUP 1
BID PACKAGE NO.2
EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS
FC-4906A and FC-7383A

Atlanta, Georgia

Andre Dickens

Mayor
City of Atlanta

Mikita K. Browning
Commissioner
Department of Watershed Management

Jaideep Majumdar
Chief Procurement Officer
Department of Procurement

EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS
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CITY OF ATLANTA, GEORGIA

Andre Dickens
Mayor

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TECHNICAL SPECIFICATIONS

CITY OF ATLANTA
EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS
FC-4906A AND FC-7383A

Seals for Technical Specifications are as follows:

Divisions 01, 11, 14, 15
Hamilton D. Giles, PE
Georgia Registration No. 041536

Division 02
Dave Wilson, PE
Georgia Registration No. 031826

Divisions 03 – 10, 12, 13
Housam Hobi, PE
Georgia Registration No. 041058

Division 15
John Kulbaga, PE
Georgia Registration No. 045036

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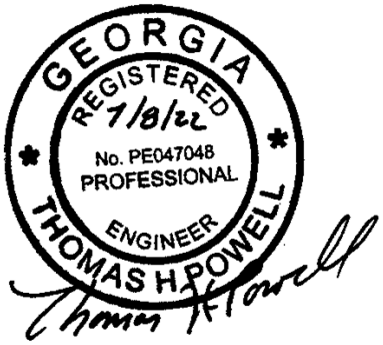

East Area WQCF Improvements

Division 17
Federico Guillermo Arango Jaramillo, PE
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TECHNICAL SPECIFICATIONS

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TECHNICAL SPECIFICATIONS

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DIVISION 1

GENERAL REQUIREMENTS

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SECTION 01005

MISCELLANEOUS REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

The Contractor shall conform to all miscellaneous requirements as herein specified.

1.2 INTERFERENCE WITH EXISTING WORKS

A. The Contractor shall at all times conduct his operations so as to interfere as little as possible with existing works. The Contractor shall develop a program, in cooperation with the Engineer and plant personnel, which shall provide for the construction and putting into service of the new works in the most orderly manner possible. This program shall be adhered to except as deviations therefrom are expressly permitted. All work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time when the demands on the facilities best permit such interference, even though it may be necessary to work outside of normal working hours to meet these requirements. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.

B. The Contractor shall make such minor modifications in the work relating to existing structures as may be necessary, without additional compensation.

C. The Contractor shall have no claim for additional compensation by reason of delay or inconvenience in adapting his operations to meet the above requirements.

1.3 MAINTAINING SEWAGE WATER, AND STORM WATER FLOWS AND OTHER UTILITIES AND PROCESS FLOWS

A. It is essential to the operation of the existing facilities system that there be no interruption in the flow of aforementioned utilities, except as expressly scheduled in Section 01100. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as dams, pumping equipment, conduits, and all other labor and equipment necessary to intercept these utilities before it reaches the points where it would interfere with his work, carry it past its work, and return it to the existing utility below its work.

B. Minimum facility usage flow occurs during periods of dry weather. During periods of wet weather that result in a CSO event, defined as flow which exceeds the capacity of the sanitary sewer, or other times when the City is required to operate the facilities, the Contractor's Work may be interrupted. Unless otherwise indicated, facilities must remain operational at all times.

1.4 PHASE CONSTRUCTION

Work under this contract is to be accomplished in a timely manner and in accordance with the completion time set forth in the Bid Proposal of Volume I, Bidding Documents for this project.

1.5 MOTOR AND STARTING EQUIPMENT DATA LIST

A. Each Contractor shall obtain the necessary data from its equipment suppliers, and shall prepare a complete tabulation of all motors over 1/3 hp., and all electric heaters., to be furnished under his contract.

B. The motor and heater tabulation shall include firm and accurate information as follows:

1. Name and identification of equipment.
2. Manufacturer.
3. Horsepower or kilowatt rating.
4. Voltage.
5. Phase.
6. Speed.
7. Full load current.
8. Locked rotor current or code letter.
9. Type of enclosure (open dripproof, totally enclosed, fan cooled, etc.)
10. Automatic control equipment used (if applicable).
11. NEMA size of starter or contactor.
12. Overload heater size.
13. Type of starter (full voltage, reduced voltage, autotransformer, etc.).
14. Breaker trip setting or fuse size.
15. Voltage of starter operating coil.
16. If starter is at a motor control center, list motor control center number.

C. The correct submission of starting equipment shop drawings is dependent upon timely submission of the complete motor and electric heater tabulation. To this end, all Contractors shall cooperate fully in the assimilation and dissemination of motor and electric heater data.

D. Three copies of the tabulation shall be furnished to the Engineer. The Contractor or his electrical sub-contractor shall also prepare a composite tabulation of all of these motors and electric heaters, as specified under ELECTRICAL WORK GENERAL.

1.6 VOLTAGE RATINGS OF MOTORS

Unless otherwise specified, motors with ratings in excess of 1/3 hp. shall be rated 460 volt (nameplate rating), three phase, 60 Hertz; motors of 1/3 hp. or less shall be rated 115 volt, single phase, 60 Hertz.

1.7 HYDRAULIC UPLIFT OF STRUCTURES

The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the City.

END OF SECTION

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SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.1 DESCRIPTION

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

A. Sedimentation basin modifications, including new sludge pumps, replacement sludge collectors, and new instrumentation;
   1. Demolish the existing 8-inch sludge piping where it leaves the existing building.
   2. Removal of sludge from Sedimentation Basin No. 2 and disposal offsite. This work shall be included in the contractor base bid.
   3. Removal of sludge from Sedimentation Basin No. 1 and disposal offsite. This work is included as an additive alternate to the contract.
   4. Remove the existing sludge cross collectors, including the collector drive units and appurtenances from the existing settling basins (2 basins).
   5. Reconfigure the existing sludge cross collector trough, as shown on the contract drawings, to accommodate the installation of eight (8) new submersible sludge pumps (4 pumps per basin), as shown and/or specified in the contract documents.
   6. Furnish and install eight new submersible sludge pumps, including discharge piping and valves, guide rails, access platforms, handrails, and all other work and appurtenances shown and/or specified in the contract documents.
   7. Remove the existing chain and flight sludge collector mechanisms, drives, bearings, sprockets, and accessories. Install all new chain and flight sludge collectors mechanisms and drives.

B. Sludge handling system improvements, including sludge holding tank and solids processing pump station rehabilitation.
   1. Demolish the existing clarifier mechanism, piping, handrail and other appurtenant equipment in the existing sludge

holding tank as shown and/or specified in the contract documents.

2. Make structural repairs to the tank as shown and/or specified in the contract documents. Contractor is required to inspect all above-grade exterior and interior surfaces of the sludge holding tank.
3. Apply new coating system to the tank interior.
4. Install a new clarifier mechanism, including piping and valves, electrical and instrumentation work, in the existing sludge holding tank as shown and/or specified in the contract documents.
5. Install new handrail around the sludge storage tank, along the walkway, and stairs, as shown and/or specified in the contract documents.

C. Existing solids processing pump station rehabilitation:

1. Demolish existing pumps, piping and electrical equipment as shown and/or specified in the contract documents.
2. Repair visible cracks in concrete floors and walls. Seal all concrete joints.
3. Clean grit and sludge from the existing piping and clean existing metal piping to remove paint.
4. Clean floor drain lines and replace all floor drains.
5. Test all existing water lines.
6. Clean the building interior and repaint all walls.
7. Repair existing hoist.
8. Install new pumps and piping.
9. Install new electrical equipment

D. Sludge dewatering building with belt filter presses and all associated equipment;

1. Demolish the existing centrifuge dewatering facility, and relocate/dispose of the existing equipment per owners requirements.
2. Furnish and install a new sludge dewatering facility, including a pre-engineered building on concrete foundations, sludge dewatering and handling equipment, chemical system, piping and valves, civil work, structural work, electrical work, plumbing work, HVAC work, instrumentation and control work, and all appurtenances as shown and/or specified in the contract documents, for a complete and workable installation.

E. Install sampling equipment and instrumentation upstream and downstream of the sedimentation basins to monitor ~~dissolved oxygen,~~ pH and total chlorine residual.

1. Sample point No. 1 (upstream location) – install new sampling equipment and instruments, including piping and valves, electrical and instrumentation work, in the new FRP cabinet on a new concrete pad as shown and/or specified in the contract documents.
2. Sample point No. 2 (downstream location) – install new sampling equipment and instruments, including piping and valves, electrical and instrumentation work, in the filter building on a new skid as shown and/or specified in the contract documents.

F. Chemical System repairs at the EA WQCF and the Custer Avenue CSCF;

1. Sodium Hypochlorite System piping and appurtenant equipment improvements (EA WQCF) as shown and or specified in the contract documents.
2. Sodium Hypochlorite Dosing and sampling point improvements (EA WQCF).
3. Sodium Bisulfite System piping and appurtenant equipment improvements (EA WQCF) as shown and or specified in the contract documents.
4. Sodium Bisulfite System piping and appurtenant equipment improvements (Custer Ave CSCF) as shown and or specified in the contract documents.

G. Tunnel outfall flume repair work, including demolition of a portion of the existing structure, civil work, concrete work, and appurtenances, as shown and or specified in the contract documents.

H. Custer Avenue Tunnel Gate Repairs:

1. Stabilize the existing tunnel gate frame as shown and or specified in the contract documents.
2. Adjust the existing limit switches as shown and or specified in the contract documents.

1.2 PERMITTING

A. The Contractor shall be responsible for obtaining permits for the work specified in paragraph 1.1. At minimum, the following permits are likely to be required for the work summarized in paragraph 1.1:

1. Erosion and Sediment Control Land Disturbance Permit
2. Nationwide 404 Permitting
3. DeKalb County Stream Buffer Variance

4. Dekalb County and City of Atlanta Building Permitting

B. The Contractor shall include in the base bid the cost associated with the permits required to perform the work described in paragraph 1.1.

C. Contractor responsibility to determine fee amount for all permits. Contractor shall be required to go to COA Building Department and DeKalb County Building Department to obtain the information and ask questions as required to determine the permit fees for site, building, electrical, plumbing, mechanical and electrical which will be included in the lump sum bid amount. Review of website or other methods to determine any fees are not acceptable.

D. Contractor is advised the City of Atlanta building permit fee will be based on a percentage of the entire bid amount and will not exceed 0.7% of the entire bid amount including the allowances. This fee amount is in addition for other City of Atlanta fees for specific work and trades such as Electrical, HVAC, Plumbing, Elevator, Site Development and other work detailed in these contract documents.

E. Refer to Section 01060, Regulatory Requirements for additional permitting requirements.

1.3 SUBSTANTIAL COMPLETION AND FINAL COMPLETION DATES

A. Project substantial completion - 480 days after NTP.

B. Project final completion - 540 days after NTP.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01011

UNIQUE REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

The scope of this Section is to convey to the Contractor unique and unusual stipulations and requirements, which have been established for this Project. Some of the stipulations and requirements are a result of negotiations with various entities and organizations, which have an interest in this Project. Some requirements are based on technical aspects of the Project, which are not otherwise conveyed to the Contractor. The provisions of this Section shall supersede the provisions of the Division 1 through 17 Specifications, but shall not supersede the Bidding Requirements, Contract Forms or Conditions of the Contract.

1.2 EXISTING FACILITY OPERATIONS

A. Part of the existing facilities must of necessity remain in operation while the new construction is in progress.

East Area WQCF

1. One settling basins shall remain in service at all times. Settling basin #2 needs to be repaired first and then install new pumps and piping. Once basin #2 is repaired and pumps operational, take basin #1 out of service and repair and replace pumps and piping.
2. All electrical equipment except for limited downtime required to replace/ connect new equipment piping, as coordinated with the City.
3. All chemical equipment except for limited downtime required to replace piping and valves, as coordinated with the City.
4. Access for chemical deliveries.
5. Access for City personnel to operate the CSCF and WQCFs.

B. The Contractor shall coordinate the Work with the City so that the construction will not restrain or hinder the operation of the existing facilities.

C. After having coordinated the Work with the City, the Contractor shall prepare a submittal in accordance with Section GC-26 to include the time, time limits, and methods of each connection or alteration and have the approval of the City or the City's Engineer before any Work is undertaken on the connections or alterations.

1.3 SEQUENCING

A. General: The Contractor shall be solely responsible for all construction sequencing.

B. Notify the City at least 48 hours prior to impacting operations.

C. Sequence Submittal:
   1. Submit a proposed sequence with appropriate times of starting and completion of tasks to the City Engineer for review.
   2. The Contractor may propose alternatives to the sequencing constraints shown in this Section in an attempt to reduce the disruption of the operation of the existing facility or streamline the Work. The City and City Engineer are not obligated to accept any of these alternatives.

1.4 SITE SPECIAL REQUIREMENTS

A. General
   1. Parking for Contractor personnel shall be fully contained within the site boundaries. No parking is permitted on any public roads or on any streets. If necessary, the Contractor shall make arrangements for remote parking for its personnel, at a site approved by the City, at no additional cost to the City.
   2. Contractor is advised there are numerous pressurized pipes, energized conduits and duct banks, overhead utilities, and gravity flow systems on the site. The Contractor is responsible for protecting the existing utility lines and shall be responsible for the repair and damages resulting from his construction activities to these systems. In addition to the requirements of Section SC-8 the Contractor is required to verify the actual locations of various buried lines shown in the Drawings by carefully excavated test pits and other direct means before starting Work in any given areas at no additional cost to the City. Special care shall be taken during any excavation to mitigate damage potential in case previously unknown and active systems are encountered. Overhead utilities may require raising or relocation to access site.
   3. Unless shown otherwise on the Drawings, the Contractor shall restore the site to its original grade. Any fill placed at the site to return it to its original grade shall be controlled fill, approved by the Engineer. The site shall be grassed and strawed. Any final landscaping, including trees and shrubs, but not including grassing, shall be paid for under an allowance item.
   4. The Contractor shall be responsible for maintaining and cleaning site access roads from the date it occupies the Site through the final completion of the construction period.

B. Custer Avenue CSCF
   All traffic must enter and exit the site Custer Avenue.

C. East Area WQCF
All traffic must enter and exit the site via Key Road.

END OF SECTION

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SECTION 01014

WORK SEQUENCE

PART 1 - GENERAL

1.1 SCOPE

A. Work under this Section includes construction sequencing and provision of temporary facilities necessary to maintain the ability of the City to process storm water as may be required during wet weather/CSO events. The design flows for each facility are as follows:

Facility Name	Flow (MGD)
Clear Creek CSCF	7,700
Tanyard Creek CSCF	3,985
North Avenue CSCF	3,250
West Area WQCF	85
Boulevard Regulator	2,295
Custer Avenue CSCF	3,050
East Area WQCF	20

B. The Contractor shall coordinate the work to avoid any interference with normal operation of plant equipment and processes. The Contractor shall comply with the following general requirements:

1. Provide temporary pumps and other facilities necessary to meet the requirements of this Section.
2. Notify the Engineer at least 48 hours prior to impacting operations.
3. Bypassing of untreated or partially treated storm water to surface waters or drainage courses is prohibited during construction. In the event accidental bypassing is caused by the Contractor's operations, the City shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor.

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

D. Work to be completed under other contracts included in the City’s CSO Various Projects, Group 1 program include:

Bid Package #1, Clear Creek Chemical System Improvements and System Wide Flow Monitoring

1.2 SUBMITTALS

A. The Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment or structure from service. The schedule shall be coordinated with the construction schedule specified in the Special Conditions and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for preventing bypassing of other treatment units, the length of time required to complete said operation, the necessary plant, and equipment which the Contractor shall provide in order to prevent bypassing of associated treatment units.

B. Sequence Submittal: Submit a proposed sequence with appropriate times of starting and completion of tasks to Engineer for review.

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

1.3 QUALITY ASSURANCE

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

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

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

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

B. Items listed in this section may be generally constructed concurrently. Contractor shall provide the Sequence of the Work plan, to the Engineer/City, for approval, prior to beginning the work.

3.2 EA WQCF

A. Sedimentation basin modifications, including new sludge pumps, piping and new instrumentation;
   1. Demolish the existing 8-inch sludge piping where it leaves the existing building.
   2. Remove the existing sludge cross collectors, including the collector drive units and appurtenances from the existing settling basins (2 basins).
   3. Reconfigure the existing sludge cross collector trough, to accommodate the installation of eight (8) new submersible sludge pumps (4 pumps per basin).
   4. Furnish and install eight new submersible sludge pumps, including discharge piping and valves, guide rails, access platforms, handrails, instrumentation and all other work and appurtenances.

B. Sludge handling system improvements, including sludge holding tank and solids processing pump station rehabilitation.
   1. For the existing sludge holding tank:

      a. Sludge holding tank is to be cleaned. Contractor shall pump any accumulated stormwater from the tank to the manhole connected to the sludge tank drain/overflow line shown on drawing, C-007.
      b. Demolish the existing clarifier mechanism, piping, handrail and other appurtenant equipment in the existing sludge holding tank as shown and/or specified in the contract documents.

c. Make structural repairs to the tank as shown and/or specified in the contract documents.
d. Apply new coating system to the tank interior.
e. Install a new clarifier mechanism, including piping and valves, electrical and instrumentation work, in the existing sludge holding tank as shown and/or specified in the contract documents.
f. Install new handrail around the sludge storage tank, along the walkway, and stairs as shown and/or specified in the contract documents.

2. For the existing Solids Process Pump Station:

a. Demolish existing pumps, piping and electrical equipment as shown and/or specified in the contract documents.
b. Repair visible cracks in concrete floors and walls. Seal all concrete joints.
c. Clean grit and sludge from the existing piping and clean existing metal piping to remove paint.
d. Clean floor drain lines and replace all floor drains.
e. Test all existing water lines.
f. Clean the building interior and repaint all walls.
g. Repair existing hoist.
h. Install new pumps and piping.
i. Install new electrical equipment

3. Sludge Dewatering Building with Belt Filter Press and all associated equipment;

a. Demolish the existing Centrifuge Dewatering Facility and relocate/dispose of the existing equipment per owners requirements.

b. Furnish and install a new sludge dewatering facility, including:
   1) a pre-engineered building on concrete foundations,
   2) sludge dewatering and handling equipment,
   3) chemical polymer system,
   4) piping and valves,
   5) civil work,
   6) structural work,
   7) electrical work,
   8) plumbing work,
   9) HVAC work,
   10) Instrumentation and control work.

C. Install sampling equipment and instrumentation upstream and downstream of the sedimentation basins to monitor pH and total chlorine residual.
   1. Sample point No. 1 (upstream location) – install new sampling equipment and instruments, including piping and valves, electrical and instrumentation work, in the new FRP cabinet on a new concrete pad as shown and/or specified in the contract documents.
   2. Sample point No. 2 (downstream location) – install new sampling equipment and instruments, including piping and valves, electrical and instrumentation work, in the filter building on a new skid as shown and/or specified in the contract documents.

D. Chemical System repairs at the EA WQCF
   1. Remove existing equipment to be replaced.
   2. Install new Sodium Hypochlorite System piping and appurtenant equipment improvements.
   3. Install new Sodium Hypochlorite Dosing and sampling point improvements.
   4. Install new Sodium Bisulfite System piping and appurtenant equipment improvements.
   5. Perform chlorination tank and pump inspection and rehabilitation.
   6. Perform dechlorination tank and pump inspection and rehabilitation.

E. Tunnel pump station outfall repair.

   Tunnel outfall flume repair work includes demolition of a portion of the existing structure, civil work, concrete work, and appurtenances, as shown and or specified in the contract documents.

3.3 CUSTER AVENUE CSCF CONTROL FACILITY

A. Chemical System Repairs;
   1. Remove existing equipment to be replaced
   2. Install Sodium Bisulfite System piping and appurtenant equipment improvements.
   3. Perform dechlorination tank and pump inspection and rehabilitation

B. Tunnel Gate Repairs:
   1. Stabilize the existing tunnel gate frame
   2. Adjust the existing limit switch settings.

END OF SECTION

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SECTION 01016

OCCUPANCY

PART 1 - GENERAL

1.1 PARTIAL OCCUPANCY BY CITY

Whenever, in the opinion of the Engineer, any section or portion of the Work is in suitable condition, it may be put into use upon the written order of the Engineer and such usage will not be held in any way as an acceptance of said work, or any part thereof, or as a waiver of any of the provisions of these Specifications and the Contract. Pending completion and final acceptance of the Work, all necessary repairs, and replacements, due to defective materials or workmanship or operations of the Contractor, for any section of the Work so put into use shall be performed by the Contractor at Contractor's own expense.

END OF SECTION

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SECTION 01040

COORDINATION

PART 1 - GENERAL

1.1 SUMMARY

A. Coordinate execution of the Work with other Contractors, subcontractors, and the Engineer as required to maintain operation of the existing facilities and satisfactory progress of the Work.

B. Requirements of this Section will be in addition to those stated in the General Conditions.

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

1.2 CUTTING AND PATCHING

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

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

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

D. Do not cut or alter the work of any subcontractor, except with the written consent of the subcontractor whose work is to be cut or altered, or with the

written consent of the Engineer. All cutting and patching or repairing made necessary by the negligence, carelessness or incompetence of the Contractor or any of its subcontractors, shall be done by, or at the expense of, the Contractor and shall be the responsibility of the Contractor.

1.3 EXISTING UTILITIES

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

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

C. Comply with the requirements of Section 01011 of these Specifications.

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 DEFINITIONS

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.

A. 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.

B. 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".

C. "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 Division 2 for additional requirements.

1.2 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.

1.3 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.

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

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Water, moisture, or vapor barriers.
4. Fire Protection Systems.

5. Control Systems.
6. Communication systems.
7. Conveying systems
8. 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.

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.

1. Stonework and stone masonry.
2. Window wall systems.
3. Ornamental metal.
4. Firestopping
5. Stucco and ornamental plaster.
6. Carpeting.
7. 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, stair systems and similar categories of work.
3. Structural concrete.
4. Foundation construction.
5. Steel.
6. Lintels.
7. Bearing and retaining walls.
8. Structural decking.
9. Exterior curtain wall construction.
10. Equipment Supports.
11. Piping, ductwork, vessels and equipment.
12. Structural systems of special construction, as specified by Division- 13 sections.
13. Shoring, bracing, and sheeting.
14. Primary operational systems and equipment.

15. Water/moisture/vapor/air/smoke barriers, membranes and flashings.
16. Noise and vibration control elements and systems.
17. 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.

1.4 SUBMITTALS

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:

A. 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.
B. List products to be used and firms including their qualifications that will perform work.
C. Give dates when work is expected to be performed.
D. 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.
E. 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.
F. 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.

1.5 WARRANTY

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 existing warranties or warranties on Work included in the contract.

PART 2 - PRODUCTS

2.1 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.

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

3.1 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.

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

3.2 PREPARATION

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.

3.3 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 a 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.

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.

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

3.4 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 01060

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. Permits and Responsibilities: The Contractor shall, without additional expense to the City, be responsible for obtaining NPDES land disturbance permits for storm water 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.

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

a. COA Building permits
b. COA Fire review permits
c. COA Public utility permit
d. COA Water service permit
e. COA Urban design Commission approval
f. NPDES Notice of Intent

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

g. COA Land disturbance permits
h. COA Site development permits

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

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

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

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

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

F. 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.

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

Fee Type	Base Fee	Technology Fee	Minimum Permit Fee Amount
Building Permit Fees	$150	$25	$175
	$7 per $1,000 of cost of construction (applies to entire contract amount including allowances)		
Electrical Permit	$150	$25	$175
Mechanical / HVAC Permit	$150	$25	$175
Plumbing Permit	$150	$25	$175
Temporary Power Permit	$150	$25	$175
Public Utility Permit	$150	$25	$175

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

1.2 NPDES PERMITS FOR STORM WATER DISCHARGES

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 (NODES) 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

SECTION 01100

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.1 CONNECTIONS TO EXISTING SYSTEMS

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

1.2 RELOCATIONS

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

1.3 EXISTING UNDERGROUND PIPING, STRUCTURES, AND UTILITIES

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

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

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

D. The Contractor shall exercise care in any excavation to locate all existing piping and utilities. All utilities, which do not interfere with complete work, shall be carefully protected against damage. Any existing utilities damaged in any way by the Contractor shall be restored or replaced by the Contractor at its expense as directed by the Engineer.

1.4 HAZARDOUS LOCATIONS

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

1.5 CONNECTIONS TO WORK BY OTHERS

Not Used.

1.6 NONEWATER FOR CONSTRUCTION PURPOSES

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01200

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SCOPE

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

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

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

1.2 SUBMITTALS

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

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

1.3 LUMP SUM ITEMS

A. Payment of the lump sum items established in the Contractor's Bid shall be full compensation for all labor, materials, and equipment required to furnish, install, construct, and test the Work covered under the lump sum bid item.

B. The lump sum items shall be specifically subdivided by Activity, broken out in the Schedule of Values.

C. Payments for the lump sum items specifically broken out in the Schedule of Values will be based upon physical progress for each activity in

accordance with the breakdown of the Lump Sum prices agreed to in the Schedule of Values.

1.4 UNIT PRICE ITEMS

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

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

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

1.5 MEASUREMENT OF QUANTITIES

A. Final payment quantities shall be determined from the record drawings. The record drawing lengths, dimensions, quantities, etc. shall be determined by a survey after completion of all required work. The precision of final payment quantities shall match the precision shown for that item in the Bid Schedule. Measurements will be taken according to the United States standard measurements and in the manner as specified in these Specifications.

B. Measurement Devices:

1. Scales shall be inspected, tested, and certified by the applicable Weights and Measures Department within the past year and shall be of sufficient size and capacity to accommodate the conveying vehicle.
2. Metering devices shall be inspected, tested, and certified by the applicable department within the past year.
3. Volume shall be determined by cubic dimension by multiplying mean length by mean width by mean height or thickness.
4. Area shall be determined by square dimension by multiplying mean length by mean width or height.

5. Linear measurement shall be measured by linear dimension, along the item centerline or mean chord.
6. Stipulated price measurement shall include items measured by number, weight, volume area, length or combination thereof as appropriate.

Item	Method of Measurement
AC	Acre—Field Measure
AL	Allowance
CY	Cubic Yard—Field Measure within limits specified or shown, or measured in vehicle by volume, as specified
EA	Each—Field Count
GAL	Gallon—Field Measure
HR	Hour
LB	Pound(s)—Weight Measure by Scale
LF	Linear Foot—Field Measure
LS	Lump Sum—Unit is one; no measurement will be made
SF	Square Foot
SY	Square Yard
TON	Ton—Weight Measure by Scale (2,000 pounds)
VF	Vertical Foot—Field Measure

1.6 ALLOWANCES

A. The allowances specified in the Bid Schedule are to establish a fund to pay the cost of items for which the City could not establish accurate quantities and/or detailed scope of work. This work shall be completed only at the written direction of the Engineer, and the cost of such work shall be approved prior to performance of the work.

B. The Contractor shall be responsible for the payment for these services to the appropriate payee providing such service, and shall submit evidence of payments to the Engineer prior to its inclusion in the progress payments.

C. Payment will be made for invoices submitted by the Contractor subject to the conditions and limitations in the Contract Documents. Unless expressly indicated otherwise in allowance item descriptions below, all Contractor costs associated with the Work shall be determined as prescribed in the General Conditions, GC-41.2.4, Force Account Work.

D. Allowance allocations shall only be paid to the Contractor for completed work authorized by the Engineer. All allowance dollar amounts not

expended shall revert to the City at the completion of the project. Should the final allowance costs be less than the specified amount of the allowance, the Contract will be adjusted accordingly by change order. The amount of change order will not recognize any changes in handling costs at the site, labor, overhead, profit and other expenses caused by the adjustment to the allowance item.

1.7 ITEM NO. 1.1 – EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS

A. Measurement for payment shall be per lump sum.

B. All Work required to provide complete and fully functional systems at the EA WQCF in accordance with the drawings and technical specifications. Work generally includes:

1. Replacement of existing sedimentation basin sludge pumps with new submersible sludge pumps and piping
2. Installation of new instruments and sampling pumps at sedimentation basins
3. Construction of improvements to the existing sludge holding tank
4. Improvements to the existing Solids Processing Pump Station
5. Replacement/repair of chemical feed system components and containment areas
6. Improvements to the existing Tunnel Outfall Structure
7. Various electrical system improvements
8. Various Instrumentation and Controls Systems improvements
9. Demolition and salvage of materials and equipment as required by the City and disposal of all other items not designated for salvage.

1.8 ITEM NO. 1.2 – CUSTER AVENUE CSCF CHEMICAL SYSTEM IMPROVEMENTS

A. Measurement for payment shall be per lump sum.

B. All Work required to complete repairs to the Sodium Bisulfite chemical storage and dosing system at the Custer Avenue CSCF in accordance with the drawings and technical specifications. Work generally includes:

1. Replacement/repair of chemical feed system components.
2. The work also includes all associated material appurtenances, and electrical work as well as associated configuration, calibration, and startup work in accordance with the drawings and specifications.

1.9 ITEM NO. 1.3 – PERMITS

A. Measurement for payment shall be per lump sum.

B. All costs involved with obtaining and executing required permits for the project shall be included in the lump sum bid for this item.

1.10 ITEM NO. 1.4 – ALL OTHER WORK

A. Measurement for payment shall be per lump sum.

B. All work to complete the Project, and which is not included in any other items, shall be included in the lump sum amount bid for this item.

C. All mobilization and demobilization costs shall be included in this Bid Item. This shall include costs for all sites where Work is shown or specified.

1.11 ITEM NO. 3.1 - FOXBORO SYSTEM UPDATES

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for system modifications to be made to the Foxboro DCS for a fully-functional SCADA system as specified in Section 17500. The Work includes, but is not limited to, the following:

1. Upgrade control panel CP-CF located in the CSO Chemical Building.
2. Upgrade control panel CP-SP located in the CSO Sludge Pump Station.
3. Add new Input-Output cards in control panel CP-FB located in the CSO Filter Building.
4. Add new redundant communication module in the control panel located in the Intrenchment Creek Admin Building.
5. Provide programming, testing and startup services.

B. Identify the Foxboro Allowance on the Schedule of Values and submit invoice with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the Foxboro Allowance.

1.12 ITEM NO. 3.2 – PARTNERING

An allowance has been established as the value of this item. This allowance may be used to pay the City's 50 percent share of the costs of an outside facilitator and conference facilities to conduct partnering in accordance with these Specifications. The Contractors costs for attending and participating in the partnering sessions is not covered under this allowance item and all such costs shall be included in Lump Sum Bid amount for All Other Work. The Contractor shall allocate an amount equal to this allowance in its Lump Sum Bid for paying its 50 percent share of the direct Partnering costs. Any unused portion of the amount allocated by the Contractor for its 50 percent share of the direct costs of Partnering shall be credited to the City on the Final Payment Request. Payments by the Contractor under this allowance are considered as "pass through costs" for which the Contractor will not be entitled to any markup.

1.13 ITEM NO. 3.3 – UNFORESEEN CONDITIONS

An allowance has been established as the value of this item. This allowance may be used to pay the costs for Unforeseen Conditions as directed by the Engineer. This allowance covers the cost of relocating utilities or other structures or demolishing structures not shown on the Drawings.

1.14 ITEM NO. 3.4 – EA WQCF SOLIDS PROCESSING PUMP STATION HOIST REPAIR

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for rehabilitation of the existing hoist and accessories at the Solids Processing Pump Station at the EA WQCF and Contractor's fees for assistance in completing the assessment and rehabilitation as described in the following Parts.

B. Following the Contractor's Notice to Proceed, the specified equipment manufactures shall make a site visit, in the presence of the Engineer, to evaluate the condition of their respective equipment. The equipment manufactures shall then prepare a condition assessment report, a scope of services, and price proposal to rehabilitate their respective equipment. The Contractor will assemble the reports and pricing from all the equipment manufacturers, into one complete report, and provide to the Engineer/City for approval.

C. Contractor shall provide all labor, materials, equipment and assistance required for the repair of the hoist system, which is not expressly designated as being performed by the equipment manufacturers, in their revised proposal. Work generally includes:
   1. Coordination of the work.
   2. Cleaning and housekeeping
   3. Provision of access to equipment and all heavy lifting.
   4. All work required for complete and proper rehabilitation of the pump station.

D. Identify the EA WQCF Hoist Repair Allowance on the Schedule of Values and submit equipment manufactures and Contractor invoices with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the Solids Processing Pump Station Rehabilitation Allowance.

1.15 ITEM NO. 3.5 – EAST AREA HYPOCHLORITE TANK AND FEED PUMP INSPECTION AND REPAIR

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for the Hypochlorite Tank and Feed Pump Inspection and Repair at the EA WQCF and Contractor's fees for assistance in completing the inspection and repairs as described in Part

B below and in the Contract Documents. Scope information for the Hypochlorite Tank and Feed Pump Inspection and Repair is included in Section 11920 of the specifications.

B. Following the Contractor's Notice to Proceed, the specified equipment manufacturers shall make a site visit, in the presence of the Engineer, to evaluate the condition of their respective equipment. The equipment manufactures shall then prepare a condition assessment report, a scope of services, and price proposal to repair their respective equipment. The contractor will assemble the reports and pricing from both equipment manufacturers, into one complete report, and provide to the Engineer/City for approval

C. Contractor shall provide all labor, materials, and assistance required for the Hypochlorite Tank and Feed Pump Inspection and Repair, which is not expressly designated as being performed by the equipment manufacturers, in their revised proposal. Work generally includes:
   1. Cleaning and Housekeeping
   2. Coordination of the work.
   3. Temporary lighting and electrical power
   4. All heavy lifting.
   5. All work required for complete and proper installation of the equipment repairs.

D. Identify the Hypochlorite Tank and Feed Pump Inspection and Repair Allowance on the Schedule of Values and submit equipment manufacture and Contractor invoices with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the East Area Hypochlorite Tank and Feed Pump Inspection and Repair Allowance.

1.16 ITEM NO. 3.6 – EAST AREA BISULFITE TANK AND FEED PUMP INSPECTION AND REPAIR

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for the Bisulfite Tank and Feed Pump Inspection and Repair at the EA WQCF and Contractor's fees for assistance in completing the inspection and repairs as described in Part B below and the in the Contract Documents. Scope information for the Bisulfite Tank and Feed Pump Inspection and Repair is included in Section 11920 of the specifications.

B. Following the Contractor's Notice to Proceed, the specified equipment manufactures shall make a site visit, in the presence of the Engineer, to evaluate the condition of their respective equipment. The equipment manufactures shall then prepare a condition assessment report, a scope of services, and price proposal to repair their respective equipment. The

contractor will assemble the reports and pricing from both equipment manufacturers, into one complete report, and provide to the Engineer/City for approval

C. Contractor shall provide all labor, materials, and assistance required for the Bisulfite Tank and Feed Pump Inspection and Repair, which is not expressly designated as being performed by the equipment manufacturers, in their revised proposal. Work generally includes:
   1. Cleaning and Housekeeping
   2. Coordination of the work.
   3. Temporary lighting and electrical power
   4. All heavy lifting.
   5. All work required for complete and proper installation of the equipment repairs.

D. Identify the Bisulfite Tank and Feed Pump Inspection and Repair Allowance on the Schedule of Values and submit equipment manufacture and Contractor invoices with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the East Area Bisulfite Tank and Feed Pump Inspection and Repair Allowance.

1.17 ITEM NO. 3.7 – CUSTER AVENUE TUNNEL GATE REPAIRS

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for the Custer Avenue Tunnel Gate Improvements as described in the Contract Documents. Scope information for the Custer Avenue Tunnel Gate Improvement is shown on drawing M-021 of the Contract Drawings.

   1. Following the Contractor's Notice to Proceed, the contractor shall arrange for a site visit by the tunnel gate manufacturer (Rodney-Hunt) to inspect the existing tunnel inlet gate at the Custer Avenue CSCF, to assess the condition and structural integrity of the existing gate installation, including but not limited to:
      - All wall mounting(s) and other gate anchorage appurtenances
      - Gate seats
      - Gate operator
      - Gate operator support
      - Gate control system
      - Limit switch settings
   2. The gate manufacturer shall prepare a written report addressing:
      - The condition of the gate and operator
      - Any recommended gate/operator repairs
      - Any recommended concrete repairs

- New Limit switch settings to prevent over-stressing the gate assembly
- Any recommended Electrical/ control repairs
- Final Coating/Painting repairs

3. The contractor shall submit to the engineer and City a proposal to provide all labor, materials and equipment to perform any recommended gate repairs, operator repairs, concrete repairs and adjustment of limit switch settings. The proposal shall include the cost of the site visit and gate assessment report, recommendations and price development by the gate manufacturer and the contractor's costs.
4. Upon approval from the City, contractor shall procced with the tunnel gate repairs. No repair work shall begin without written direction from the City, to do so.

B. Contractor shall provide all labor, materials, and assistance required for the Custer Avenue Tunnel Gate Improvements which is not expressly designated as being performed by the equipment manufacturers, in their revised proposal. Work generally includes:
1. Cleaning and Housekeeping
2. Coordination of the work.
3. Temporary lighting and electrical power
4. All heavy lifting.
5. All work required for complete and proper installation of the equipment repairs.

C. Identify the Custer Avenue Tunnel Gate Improvements Allowance on the Schedule of Values and submit Contractor invoices with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the Sedimentation Basin Water Leak Source Identification and Repairs Allowance.

1.18 ITEM NO. 3.8 – CUSTER AVENUE BISULFITE TANK AND FEED PUMP INSPECTION AND REPAIR

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for the Bisulfite Tank and Feed Pump Inspection and Repair at the Custer Avenue CSCF and Contractor's fees for assistance in completing the inspection and repairs as described in Part B below and the in Contract Documents. Scope information for the Custer Avenue Bisulfite Tank and Feed Pump Inspection and Repair is included in Section 11920 of the specifications.

B. Following the Contractor's Notice to Proceed, the specified equipment manufactures shall make a site visit, in the presence of the Engineer, to evaluate the condition of their respective equipment. The equipment

manufactures shall then prepare a condition assessment report, a scope of services, and price proposal to repair their respective equipment. The contractor will assemble the reports and pricing from both equipment manufacturers, into one complete report, and provide to the Engineer/City for approval

C. Contractor shall provide all labor, materials, and assistance required for the Custer Avenue Bisulfite Tank and Feed Pump Inspection and Repair, which is not expressly designated as being performed by the equipment manufacturers, in their revised proposal. Work generally includes:
   1. Cleaning and Housekeeping
   2. Coordination of the work.
   3. Temporary lighting and electrical power
   4. All heavy lifting.
   5. All work required for complete and proper installation of the equipment repairs.

D. Identify the Custer Avenue Bisulfite Tank and Feed Pump Inspection and Repair Allowance on the Schedule of Values and submit equipment manufacture and Contractor invoices with the standard payment request. Approval of the payment request shall constitute authorization by the Owner for use of the requested funds from the East Area Bisulfite Tank and Feed Pump Inspection and Repair Allowance.

1.19 ITEM NO. 3.9 – TREE REMOVAL RECOMPENSE

An allowance has been established as the value of this item. This allowance may be used to pay the costs associated with removal of tress as may be required for the Work and approved for removal by permit issued by the City of Atlanta, Arborist Division.

1.20 ITEM NO. 3.10 – SEDIMENTATION BASIN STRUCTURAL REPAIRS

A. An allowance has been established as the value of this item. This allowance may be used to pay the costs for structural repairs to the East Area WQCF sedimentation basins, and to a beam and walkway that span the basin exterior walls. A significant lateral deflection has been observed at the top of basin #2 south exterior wall, which has resulted in cracking of the concrete beam and spalling of concrete where the aluminum walkway attaches to the wall.

B. The ENGINEER will perform a structural investigation and design the needed repairs to address the issues. The repairs to be performed will be documented in the revised drawings and specifications. CONTRACTOR will be required to perform the repairs shown in the revised documents. Costs for repairs will be billed to this allowance item.

C. Identify the Sedimentation Basin Structural Repairs Allowance on the Schedule of Values and submit price proposal for review and approval by ENGINEER. Approval of the price proposal shall constitute authorization by the OWNER for use of the requested funds from the Sedimentation Basin Structural Repairs Allowance.

1.21 ITEM NO. 4.1 – SEDIMENTATION BASIN NO. 1 SLUDGE REMOVAL

A. An additive alternate is requested for this work. This work includes removal of accumulated sludge from Sedimentation Basin No. 1 and disposal off-site, inclusive of all hauling and disposal fees.

B. Payment shall be per Parts 1.4 and 1.5 of this specification.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01200

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SECTION 01350

PROJECT DOCUMENT TRACKING AND CONTROL SYSTEM

1.1 SCOPE

A. The Contractor shall utilize City of Atlanta's Project Management System (e-Builder) for project document tracking and control. The primary function of the system is to facilitate timely processing and approval of all contract documentation in coordination with the overall Project Schedule established by these Specifications and the Contractor. e-Builder will utilize an internet application for document tracking and control and will provide the following benefits:

1. Facilitate communication among the Owner, Engineer and Contractor;
2. Facilitate turn-around time with regard to responses and approvals;
3. Facilitate processing of pay applications;
4. Use for transmittal, processing and retention of submittals, RFI's, Change Notifications, daily logs, etc.
5. Provide a central location for retention of Project information to facilitate all Project participants in performing their tasks based on the latest Project data;
6. Provide a standard system of project administration with accountability.

B. The Contractor shall be required to utilize the web-based application residing at https://www.ebuilder.net to generate documents in the proper format for submission to the City. The Contractor shall access e-Builder through the internet using a compatible web browser from the Contractor's administrative field office location, and/or other locations where work associated with the Project is being performed.

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

D. The Contractor shall utilize a high capacity scanner capable of scanning document sizes up to 11" x 17", double sided, on site for the entire duration of the Project. All documents must be scanned and attached to the appropriate e-Builder document in the appropriate file.

E. The Contractor shall utilize e-Builder to create and maintain Project documents, including, but not limited to the following:

1. Company Directory: Addresses, Phone Numbers, Personnel Contacts, etc.;
2. Drawings Log: Current Drawing revision log;
3. Submittals (Integrated with Project Schedule through Activity codes);
4. Transmittals;
5. Requests for Information and Answers (RFIs) ;
6. Change Documents, Including:
    a. Work Authorizations (WAs);
    b. Change Order Requests (CORs);
    c. Change Orders (CO).
7. Daily Reports (Daily Diaries);
8. Field Decisions & Clarification Memos;
9. Notice of Non-Compliance;
10. Construction Issue Memos;
11. Punch lists;
12. Meeting Minutes & Agendas;
13. Correspondence;
14. Work Plans;
15. Start-up Plans;
16. Equipment Operation and Maintenance Training; and
17. Spare Parts.

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

G. Software Support

1. The Contractor shall be required to establish an internet connection to connect to e-Builder to permit the forwarding and receipt of documents. Internet Explorer 10.1 or higher software is required.

   The Contractor shall provide for two (2) days of consulting services in the base bid for setup configuration and troubleshooting e-Builder at any location designated by the City or at the Contractor's administrative field office (if authorized by the City). The Consultant utilized shall be approved by DWM in writing, based on a scope pre-defined by the City of Atlanta. The Contractor shall

utilize the custom data fields, dictionaries, and coding systems as required by the City of Atlanta.

2. The Contractor shall be required to attend a two (2)-day training session on the operation of e-Builder. The Contractor shall include in their base bid for five (5) participants to attend the training session. The Contractor shall be responsible for cost of training additional members of their firm or future retraining, as may be deemed necessary by the Contractor. An e-Builder trainer will be provided by the City.
3. The Contractor shall meet with the City within five (5) days after the Contract is awarded to discuss access requirements and the Contractor's plan to utilize e-Builder and execute the document control functions herein.

   The Contractor's e-Builder access shall be operational within ten (10) days following the Project's Notice to Proceed by the City.

1.2 COMPANY DIRECTORY

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

1.3 DRAWING LOG

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

1.4 SUBMITTALS/SHOP DRAWINGS

A. Requirements: This section specifies supplemental requirements related to processing of submittals and shop drawings. The Contractor will utilize e-Builder to log and track submittals, as well as generate associated transmittal letters.

B. Submittals & Product Data: A list of all required submittals will be entered into e-Builder by the Contractor. Submittals shall be incorporated into packages, with numbering to be provided by City's engineer. E-Builder will be used to log and track all submittals by the Contractor and document any reviews conducted by the City

C. The Contractor shall identify as activities in the CPM schedule, specified in SC-16, to include all data submittals, as well as those involving complex reviews and long lead deliveries, and all procurement items required for construction activities. Submittal schedule information shall be updated monthly with the Contractor's updated project CPM schedule, as specified in SC-16. The updated monthly CPM schedule shall be uploaded as a pdf file into e-Builder and electronically transmitted to the City.

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

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

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

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

1.5 CORRESPONDENCE

The City shall monitor and manage project correspondence, Non-Compliance Notices, Field Decisions & Clarification Memos and Construction Issue Memo logs through e-Builder. The Contractor is responsible for generating project correspondence using a form in e-Builder to transmit information to the City.

1.6 TRANSMITTAL LOG

e-Builder will be used by the Contractor and City to monitor and manage transmittals. All Project transmittals shall be created electronically, automatically sequentially numbered and logged into e-Builder as they are created. The Contractor is responsible for utilizing e-Builder to create transmittals for items transmitted to the Owner, Engineer, Resident Inspection Staff and other Contractors.

1.7 REQUEST FOR INFORMATION & ANSWERS

The Contractor shall be responsible for generating RFIs using e-Builder. The Contractor shall notify the City when an RFI is submitted.

The City will use e-Builder to monitor and manage RFIs. The City will generate an Answer document in response to each RFI and transmit it to the Contractor

through e-Builder. E-Builder will also be used to track "Ball in Court" for all RFIs and Answers, as well as date of original generation and response date.

e-Builder will be used to document the relative Specification Section and Drawings related to each RFI. e-Builder also will record the date of the request, the originator, responsible party for a response and the date of the response.

1.8 CHANGE DOCUMENTS
NOT USED

1.9 DAILY REPORTS

The Contractor is responsible for creating daily reports (daily diaries) utilizing e-Builder. All daily Reports shall be entered into e-Builder by the Contractor by 10:00 a.m. of the subsequent day the Contractor or any subcontractor performs work. e-Builder shall be used to transmit the reports to the City and archive the reports for future reference.

Required information for daily reports shall include Contractor, Date, Day, Temperature, Precipitation, Sky, Wind, Work Activity, Equipment, Field Force, Visitors, Materials, and Scheduled Activities utilizing the schedule activity codes. Daily reports which fail to link work activities to the active schedule will not be acceptable.

1.10 PUNCHLISTS

The City will create, monitor and manage punch lists using an e-Builder form. Punchlists will be transmitted to the Contractor electronically. The Contractor shall address Punch list items and forward updates to the City through e-Builder. Once accepted as complete, the City will access the punch list in e-Builder and close it out.

1.11 MEETING MINUTES AND AGENDA

The City shall monitor and manage the meeting minute process. The City will forward meeting minutes to the Contractor electronically. The City will log meeting minute items into the e-Builder within three (3) days of the meeting date.

1.12 PROGRESS PAYMENTS /REQUISITIONS FOR PAYMENT

The Contractor is responsible for creating progress payment applications directly within e-Builder software by 4:00 p.m. at the end of each update/billing period. The entire progress payment application will be submitted to the City electronically using e-Builder.

Four hardcopies of the original progress payment application cover sheet shall be printed and signed (in blue ink) by the Contractor. The Contractor will transmit the

original signed cover sheets to the City within 2 days of completing each progress payment application.

The Contractor shall also simultaneously provide a separate submittal of the updated progress schedule (P6 or latest version at the time of purchase), as specified in SC-16. All Progress Payments and schedule of values shall be developed as defined in the Special Conditions.

Required information within the Pay Application shall be coordinated with the City's Project Manager. Maintenance of the "As Built" record documents by the Contractor shall be verified before processing will be approved. Failure of a Contractor to maintain project record documents, maintain current and properly prepared daily reports or to submit the project schedule update per SC-16 will be just cause for withholding of the monthly or final payment.

1.13 PHOTO MANAGEMENT

e-Builder software shall be utilized by the City and Contractor for duration of the project to document and maintain project photographs. The daily construction photographs will be the permanent visual record of pre-construction conditions, daily construction site activities, and completion of construction work. The Contractor must submit to the City no less than four (4) record photos for each activity ID listed in the project schedule per the last schedule update. Applicable photos must accompany each Pay Application.

+++ END OF SECTION 01350 +++

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 SCOPE

A. From time to time during progress of the Work, the Engineer may require that testing be performed to determine that materials provided for the Work meet the specified requirements, in accordance with the requirements of the Specifications. Such testing includes, but is not necessarily limited to:
   1. Cement
   2. Aggregate
   3. Concrete
   4. Concrete block
   5. Pipe
   6. Steel and metals
   7. Welding
   8. Soil compaction
   9. Bituminous pavement

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

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

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

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

1.2 LABORATORY DUTIES

A. Cooperate with Engineer and Contractor.

B. Provide qualified personnel promptly on notice.

C. Perform specified inspections, sampling and testing of materials and methods of construction.
   1. Comply with specified standards, ASTM, other recognized authorities and as specified.
   2. Ascertain compliance with requirements of Contract Documents.

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

E. Promptly submit three (3) copies (two (2) copies to Engineer and one (1) copy to Contractor) of report of inspections and tests in addition to those additional copies required by the Contractor including:
   1. Date issued
   2. Project title and number
   3. Testing laboratory name and address
   4. Name and signature of inspector
   5. Date of inspection or sampling
   6. Record of temperature and weather
   7. Date of test
   8. Identification of product and Specification section
   9. Location of Project
   10. Type of inspection or test
   11. Results of test
   12. Observations regarding compliance with Contract Documents

F. Perform additional services as required.

G. Laboratory is not authorized to:
   1. Release, revoke, alter or enlarge on requirements of Contract Documents.
   2. Approve or accept any portion of Work.

1.3 CONTRACTOR RESPONSIBILITIES

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

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

C. Furnish copies of mill test reports.

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

E. Notify 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 or samples shall be selected by such laboratory or agency or the Engineer and shipped to the laboratory by the Contractor at Contractor's expense.

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

1.4 QUALITY ASSURANCE

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

1.5 PRODUCT HANDLING

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

1.6 FURNISHING MATERIALS

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

1.7 CODE COMPLIANCE TESTING

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

1.8 CONTRACTOR'S CONVENIENCE TESTING

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

1.9 SCHEDULES FOR TESTING

A. Establishing Schedule

1. The Contractor shall, by advance discussion with the testing laboratory determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.

2. 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.

1.10 TEST AND CERTIFICATIONS

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

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

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

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

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

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

1.11 TAKING SPECIMENS

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

1.12 TRANSPORTING SAMPLES

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

END OF SECTION

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SECTION 01416

SPECIAL INSPECTIONS AND PROCEDURES

PART 1 – GENERAL

1.1 SCOPE

A. CONTRACTOR shall provide labor, materials, tools, equipment, and incidentals as shown, specified, and required to cooperate with the coordinating special inspector, individual special inspectors, and testing agencies employed by owner, to facilitate special inspections.

B. Supplement A, Statement of Special Inspections, included with this Section, lists testing and inspections required.

1.2 DEFINITIONS

A. Coordinating Special Inspector: Professional engineer or architect, hired by OWNER, registered in the same state as the Site, responsible for coordinating and verifying the inspection and testing required by the Statement of Special Inspections included in this Section and reporting to the Building Official.

B. Building Official: Officer or other designated authority having jurisdiction charged with the administration and enforcement of the governing building code, or a duly authorized representative.

C. Special Inspections: Testing and inspection required in Supplement A, Statement of Special Inspections, of this Section.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. OWNER will employ and pay for services of the Coordinating Special Inspector, who will have not less than five years of experience in managing, monitoring, and inspecting building construction.
   2. Inspectors will be qualified in the responsibilities of the Special Inspection for which each is responsible.

B. Regulatory Requirements:

Special Inspections will be in accordance with applicable building code and other Laws and Regulations, and Supplement A, Statement of Special Inspections, of this Section.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

Samples: Representative Samples of materials when required by ENGINEER.

B. Informational Submittals: Submit the following:

1. Completed Supplement C, Contractor's Statement of Responsibility, as attached to this Section, addressing each system and component listed in the Quality Assurance Plan portion of Supplement A, Statement of Special Inspections, of this Section.
2. Completed Supplement D, Fabricator's Certificate of Compliance, as attached to this Section, for fabrication of structural steel.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Prepare Supplement C, Contractor's Statement of Responsibility, of this Section which shall include:

1. Acknowledgment of the requirements of the Quality Assurance Plan portion of Supplement A, Statement of Special Inspections, of this Section.
2. Acknowledgment that necessary quality control shall be exercised in fabricating, handling, and installing, to comply with the Contract Documents.
3. List CONTRACTOR's procedures for ensuring the quality of the Work necessary for compliance with the Contract Documents relative to each system or component listed in the Quality Assurance Plan portion of Supplement A of this Section.
4. List personnel who control the quality of the Work relative to the Contract Documents and indicate their position in the CONTRACTOR's organization.

B. Provide safe access to the Work to be tested and inspected.

C. Provide assistance in obtaining and handling test samples at the Site.

D. Facilitate inspections and tests.

E. Provide access to Suppliers' and Subcontractors' operations as required.

F. Notify Coordinating Special Inspector and ENGINEER sufficiently in advance of the Work for the Coordinating Special Inspector and ENGINEER to coordinate their personnel at the Site. Do not cover the Work to be inspected until Special Inspection has been completed and the results thereof are acceptable.

G. Special Inspections required in this Section do not supersede or make unnecessary inspections and tests required under other Specification Sections or standard inspections required by Laws and Regulations.

1.6 COORDINATING SPECIAL INSPECTOR'S RESPONSIBILITIES

A. Complete Supplement A, Statement of Special Inspections, of this Section to provide names of each inspector and testing agency for each Special Inspection required.

B. Engage services of inspectors and testing agencies for Special Inspections in accordance with Supplement A, Statement of Special Inspections, of this Section and as required by Laws and Regulations.

C. Coordinate activities of individual inspectors and testing agencies with CONTRACTOR.

D. Provide interim reports of inspections and material testing to Building Official, OWNER, and ENGINEER.

E. To obtain certificate of use and occupancy from the Building Official, complete and provide to the Building Official, OWNER, and ENGINEER Supplement B, Final Report of Special Inspections, of this Section, documenting completion of Special Inspections and correction of discrepancies noted in the Special Inspections.

1.7 INSPECTOR RESPONSIBILITIES

A. Perform specified inspections, sampling, and testing of materials and methods of construction; review and ascertain compliance with Laws and Regulations.

B. Promptly notify Coordinating Special Inspector, OWNER, ENGINEER and CONTRACTOR of irregularities or deficiencies in the Work observed during Special Inspections. Corrective action, if required, will be determined by ENGINEER.

C. Promptly submit two copies of each report of inspections and tests to Coordinating Special Inspector, ENGINEER, and CONTRACTOR including:
   1. Date issued.
   2. Project title and number.
   3. Name and signature of inspector.
   4. Date of inspection or sampling and test.
   5. Record of temperature and weather.
   6. Identification of product and Specification Section.
   7. Location in Project.
   8. Type of inspection or test.

9. Results of inspections and tests, and observations regarding compliance with Laws and Regulations, and standards.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SUPPLEMENTS

The supplements listed below, following the "End of Section" designation, are part of this Section:

A. Supplement A – Statement of Special Inspections

B. Supplement B – Final Report of Special Inspections

C. Supplement C – Contractor's Statement of Responsibility

D. Supplement D – Fabricator's Certificate of Compliance

+++ END OF SECTION +++

Supplement A - Statement of Special Inspections

Project:

Location:

Owner:

Design Professional in Responsible Charge:

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspection and Structural Testing requirements of the Building Code. It includes a schedule of Special Inspection services applicable to the Project as well as the name of the Coordinating Special Inspector and the identity of other approved agencies to be retained for conducting these inspections and tests. This *Statement of Special Inspections* encompass the following disciplines:

☐ Structural ☐ Mechanical/Electrical
☐ Architectural ☐ Other: _____

The Coordinating Special Inspector shall keep records of all inspections and shall furnish inspection reports to the Building Official and the Registered Design Professional in Responsible Charge. Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Registered Design Professional in Responsible Charge. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Inspections listed are periodic unless indicated to be continuous or required by code to be continuous.

Interim reports shall be submitted to the Building Official and the Registered Design Professional in Responsible Charge.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted prior to issuance of a Certificate of Use and Occupancy.

Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: Weekly or ☐ per attached schedule.

Prepared by:

_____
(type or print name)

_____ _____
Signature Date

Design Professional Seal

Owner's Authorization:

_____ _____
Signature Date

Building Official's Acceptance:

_____ _____
Signature Date

Schedule of Inspection and Testing Agencies

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

- ☐ Soils and Foundations
- ☐ Cast-in-Place Concrete
- ☐ Precast Concrete
- ☐ Masonry
- ☐ Structural Steel
- ☐ Cold-Formed Steel Framing
- ☐ Spray Fire Resistant Material
- ☐ Wood Construction
- ☐ Exterior Insulation and Finish System
- ☐ Mechanical & Electrical Systems
- ☐ Architectural Systems
- ☐ Special Cases

Quality Assurance Plan

Quality Assurance for Seismic Resistance

Seismic Design Category D for River, B elsewhere

Quality Assurance Plan Required (Y)

Description of seismic force resisting system and designated seismic systems:

- Ordinary concentric braced steel frames transferring lateral load to ordinary reinforced concrete shear walls.
- Seismic system installation of piping containing combustible or hazardous materials or piping where failure could damage the fire sprinkler system or other piping or equipment containing combustible or hazardous materials
- Seismic system installation of Mechanical and Process equipment containing combustible or hazardous materials
- Seismic system installation of mechanical and electrical system components located where support failure could damage piping or equipment containing combustible or hazardous materials or the fire sprinkler system
- Seismic system installation of tanks containing hazardous materials

Quality Assurance for Wind Requirements

Basic Wind Speed (three-second gust)

Wind Exposure Category C

Quality Assurance Plan Required (N)

Description of wind force resisting system and designated wind resisting components:

Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated above must submit a Statement of Responsibility.

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspections are subject to the approval of the Building Official. The credentials of all inspectors and testing technicians shall be provided if requested.

Key for Minimum Qualifications of Inspection Agents:

When Engineer deems it appropriate that the individual performing a stipulated test or inspection have a specific certification or license as indicated below, such designation shall appear below the *Agency Number* on the Schedule.

PE/SE	Structural Engineer – a licensed SE or PE specializing in the design of building structures
PE/GE	Geotechnical Engineer – a licensed PE specializing in soil mechanics and foundations
EIT	Engineer-In-Training – a graduate engineer who has passed the Fundamentals of Engineering examination

American Concrete Institute (ACI) Certification

ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1&2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III.

International Code Council (ICC) Certification

ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fireproofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT	Concrete Technician – Levels I, II, III & IV
NICET-ST	Soils Technician - Levels I, II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III & IV

Exterior Design Institute (EDI) Certification

EDI-EIFS	EIFS Third Party Inspector

Other

Soils and Foundations

Item	Agency #	Scope
1. Excavations	*PE/GE*	*Verify excavations are extended to proper depth and have reached proper material (periodic).*
2. Shallow Foundations	*PE/GE*	*Inspect subgrade below footings for adequate bearing capacity and consistency with geotechnical report (periodic).* *Inspect removal of unsuitable material and preparation of subgrade prior to placement of controlled fill*
3. Compacted Fill	*PE/GE*	*Perform classification and testing of compacted fill materials (periodic).* *Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill (continuous).* *Prior to placement of compacted fill, observe subgrade and verify that site has been prepared properly (periodic).* *Verify extent and slope of fill placement.*
4. Driven Deep Foundations	*PE/GE*	*Verify element materials, sizes and lengths comply with requirements.* *Determine capacities of test elements and conduct additional load tests, if required.* *Observe driving operations and maintain complete and accurate records for each element.* *Verify placement location and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations, and document any damage to foundation element.* *For steel elements, perform additional inspections required for Structural Steel.* *For concrete elements and concrete-filled elements, perform additional inspections for cast-in-place concrete.*
5. Cast-in-Place Deep Foundations	*PE/GE*	*Observe drilling operations and maintain complete and accurate records for each element.* *Verify placement location and plumbness, confirm element diameters, confirm bell diameters (if applicable),lengths, embedment into bedrock (if applicable), and adequate end bearing strata capacity. Record concrete or grout volumes.* *For concrete elements, perform additional inspections for cast-in-place concrete.*
6. Other:		

Cast-in-Place Concrete

Item	Agency # (Qualif.)	Scope
1. Mix Design	*ACI-CCI ICC-RCSI*	*Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.*
2. Material Certification	*PE/SE*	*Review trial batch or supporting test data to verify mix meets specified requirements. Confirm materials meet specified requirements.*
3. Reinforcement Installation	*ACI-CCI ICC-RCSI*	*Inspect size, spacing, cover, positioning and grade of reinforcing steel. Verify that reinforcing bars are free of form oil or other deleterious materials. Inspect bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters*
4. Formwork Geometry		*Inspect formwork for proper, dimensions and alignment.*
5. Welding of Reinforcing	*AWS-CWI*	*Visually inspect all reinforcing steel welds. Verify weldability of reinforcing steel. Inspect preheating of steel when required.*
6. Anchor Rods	*ACI-CCI ICC-RCSI*	*Inspect size, positioning and embedment of anchor rods. Inspect concrete placement and consolidation around anchors. (continuous)*
7. Concrete Placement	*ACI-CCI ICC-RCSI*	*Inspect placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated. (continuous)*
8. Sampling and Testing of Concrete	*ACI-CFTT ACI-STT*	*Test concrete compressive strength (ASTM C31 & C39), slump (ASTM C143), air-content (ASTM C231) and temperature (ASTM C1064).*
9. Curing and Protection	*ACI-CCI ICC-RCSI*	*Inspect curing, cold weather protection and hot weather protection procedures.*
10. Other:		

Masonry

Required Inspection Level: ☐ **1** **X 2**

Item	Agency # (Qualif.)	Scope
1. Material Certification	*PE/SE*	• *Confirm size and strength of masonry units.* • *Confirm grout mix design and materials.* • *Confirm mortar mix design and materials*
2. Mixing of Mortar and Grout	*ICC-SMSI*	*Inspect proportioning, mixing and retempering of mortar and grout. (continuous)*
3. Installation of Masonry	*ICC-SMSI*	*Inspect size, layout, bonding and placement of masonry units.*
4. Mortar Joints	*ICC-SMSI*	*Inspect construction of mortar joints including tooling and filling of head joints.*
5. Reinforcement Installation	*ICC-SMSI* *AWS-CWI*	• *Inspect placement, positioning and lapping of reinforcing steel.* • *Inspect welding of reinforcing steel. (continuous)*
6. Grouting Operations	*ICC-SMSI*	• *Inspect that masonry cells are clear of debris prior to grouting.* • *Inspect placement and consolidation of grout. (continuous)*
7. Weather Protection	*ICC-SMSI*	*Inspect cold weather protection and hot weather protection procedures. Verify that wall cavities are protected against precipitation.*
8. Evaluation of Masonry Strength	*ICC-SMSI*	*Test compressive strength of mortar and grout cube samples (ASTM C780).*
9. Anchors and Ties	*ICC-SMSI*	*Inspect size, location, spacing and embedment of dowels, anchors and ties.*
10. Other:		

Structural Steel

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures ☐ Fabricator Exempt	*PE/SE* *AWS/AIS C-SSI ICC-SWSI*	• *Verify fabricator has certification from AISC for conventional buildings of the AISC Quality Certification Program and has approval by the Building Official.* • *Review fabricator's certificate of compliance.*
2. Material Certification	*AWS/AIS C-SSI ICC-SWSI*	*Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts and welding electrodes*
3. Bolting	*AWS/AIS C-SSI ICC-SWSI*	*Inspect installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.*
4. Welding	*AWS-CWI* *ASNT*	• *Visually inspect all welds. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds. (continuous for all field welds)* • *Ultrasonic testing of all partial and full-penetration welds.*
5. Shear Connectors	*AWS/AIS C-SSI ICC-SWSI*	*Inspect size, number, positioning and welding of shear connectors. Inspect suds for full 360 degree flash. Ring test all shear connectors with a 3 lb hammer. Bend test all questionable studs to 15 degrees.*
6. Structural Details	*PE/SE*	*Inspect steel frame for compliance with structural drawings, including bracing, member configuration and connection details.*
7. Metal Deck	*PE/SE* *AWS-CWI*	• *Review manufacturer's certificate of compliance with ASTM standards specified. Verify decking section profile, gage, and properties conform to contract documents.* • *Inspect welding and side-lap fastening of metal roof and floor deck.*
8. Other:		

Anchor Systems

Item	Agency # (Qualif.)	Scope
1. Material Certification	*PE/SE*	• *Confirm anchor type (including product name), anchor dimensions, and anchor material grade for each anchor application.* • *Confirm post-installed anchor compliance with specified requirements and suitability for each application type by review of the anchor system ICC-ES Evaluation Service Report.* • *For adhesive anchors, confirm adhesive type*
2. Installation of Adhesive Anchors for Concrete, Grout-filled Masonry, and Hollow Concrete Masonry	ICC-RCSI ICC-SMSI	• *Review compliance with the installation requirements of the anchor system ICC Evaluation Service Report.* • *Verify and record anchor type (including product name), anchor dimensions, anchor material grade, adhesive type, adhesive expiration date, concrete or masonry type, base material compressive strength, drill bit type, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, anchor embedment, curing period prior to tightening, and tightening torque.* • *Inspect installation of each type and size of adhesive anchor by construction personnel on the site. (continuous)*
3. Installation of Concrete and Grout-filled Masonry Wedge Expansion Anchors	ICC-RCSI ICC-SMSI	• *Review compliance with the installation requirements of the anchor system ICC Evaluation Service Report.* • *Verify and record anchor type (including product name), anchor dimensions, anchor material grade, concrete or masonry type, base material compressive strength, drill bit type, hole dimensions, hole cleaning procedures, anchor spacing, edge distances, base material thickness, anchor embedment and tightening torque.* • *Inspect installation of each type and size of wedge anchor by construction personnel on the site. (continuous)*
4. Anchor Testing	ASNT	• *Perform tension pullout test on 10 percent of each post-installed anchor type and size.*

Wood Construction

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures ☐ Fabricator Exempt	*PE/SE*	• *For pre-fabricated wood structural elements and assemblies, verify that the fabricator maintains detailed fabrication and quality control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to the Contract Documents and approved and accepted submittals. The special inspection shall review the procedures for completeness and adequacy relative to the requirements of codes and Laws and Regulations for the fabricator's scope of the Work.* • *If exempt, review fabricator's certification for fabrication by an approved special inspection agency and certificate of compliance stating that the Work was performed in accordance with the Contract Documents and approved or accepted submittals.*
2. Diaphragms	*PE/SE*	• *Review grade and thickness of wood structural panel sheathing to verify conformance with the Contract Documents.* • *Verify nominal size of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the Contract Documents.*
3. Other:		

Mechanical & Electrical Systems

Item	Agency # (Qualif.)	Scope
1. Piping containing combustible or hazardous materials or piping where failure could damage the fire sprinkler system or other piping or equipment containing combustible or hazardous materials		• *Inspection of piping installation including vertical and lateral supports.* • *Inspection of post-installed concrete anchors for pipe, 3" and larger(continuous)*
2. Mechanical and process equipment containing combustible or hazardous materials		• *Review of manufacturer's certification that the equipment can resist the indicated seismic forces per the code without discharge of hazardous material.* • *Inspection of equipment installation and anchorage. (continuous for post-installed concrete anchors)*
3. Mechanical and electrical system components located where support failure could damage piping or equipment containing combustible and/or hazardous materials or the fire sprinkler system.		*Inspection of mechanical and electrical component installation including vertical and lateral supports.*
4. Tanks containing hazardous materials.		• *Review of manufacturer's certification that the tank and anchorage can resist the indicated seismic forces per the code without discharge of hazardous material.* • *Inspection of tank installation and anchorage. (continuous for post-installed concrete anchors)*

Architectural Systems

Item	Agency # (Qualif.)	Scope
1. Suspended Ceilings		*Inspection of suspended ceiling and associated lighting fixture installation including vertical and lateral supports.*
2.		
3.		
4.		

Special Cases

Item	Agency # (Qualif.)	Scope
1. Contractor statement of responsibility for structural seismic system construction		*Review statement of responsibility for:* • *Awareness of requirements and control needed to meet seismic requirements.* • *Procedures for exercising control and reporting on quality control* • *Identification and qualifications of person(s) in contractor's organization responsible for quality assurance for seismic system construction.*
2. Contractor statement of responsibility for seismic system installation of piping containing combustible or hazardous materials or piping where failure could damage the fire sprinkler system or other piping or equipment containing combustible or hazardous materials		*Review statement of responsibility for:* • *Awareness of requirements and control needed to meet seismic requirements.* • *Procedures for exercising control and reporting on quality control* • *Identification and qualifications of person(s) in contractor's organization responsible for quality assurance for seismic system construction.*
3. Contractor statement of responsibility for seismic system installation of mechanical and process equipment containing combustible or hazardous materials		*Review statement of responsibility for:* • *Awareness of requirements and control needed to meet seismic requirements.* • *Procedures for exercising control and reporting on quality control* • *Identification and qualifications of person(s) in contractor's organization responsible for quality assurance for seismic system construction.*
4. Contractor statement of responsibility for seismic system installation of mechanical and electrical system components located where support failure could damage piping or equipment containing hazardous materials or the fire sprinkler system.		*Review statement of responsibility for:* • *Awareness of requirements and control needed to meet seismic requirements.* • *Procedures for exercising control and reporting on quality control* • *Identification and qualifications of person(s) in contractor's organization responsible for quality assurance for seismic system construction.*
5. Contractor statement of responsibility for seismic system installation of tanks containing hazardous materials.		*Review statement of responsibility for:* • *Awareness of requirements and control needed to meet seismic requirements.* • *Procedures for exercising control and reporting on quality control* • *Identification and qualifications of person(s) in contractor's organization responsible for quality assurance for seismic system construction.*

Supplement B - Final Report of Special Inspections

Project:

Location:

Owner:

Owner's Address:

Architect of Record:

Structural Engineer of Record:

To the best of my information, knowledge and belief, the Special Inspections required for this project, and itemized in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

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

Respectfully submitted,
Special Inspector

(Type or print name)

Signature Date

Licensed Professional Seal

Agent's Final Report

Project:

Agent:

Special Inspector:

To the best of my information, knowledge and belief, the Special Inspections or testing required for this project, and designated for this Agent in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

(Attach continuation sheets if required to complete the description of corrections.)

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

Respectfully submitted,
Agent of the Special Inspector

(Type or print name)

Signature Date

Licensed Professional Seal or Certification

Supplement C - Contractor's Statement of Responsibility

Each contractor responsible for the construction or fabrication of a system or component designated in the Quality Assurance Plan of Supplement A shall submit a Contractor's Statement of Responsibility.

Project:

Contractor's Name:

Address:

License No.:

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

Contractor's Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the Project's seismic requirements, Quality Assurance Plan in Supplement A, and Special Inspection program.

I hereby acknowledge that control will be exercised to obtain conformance with the Contract Documents approved by the Building Official having jurisdiction.

_____ _____

Signature Date

Contractor's Provisions for Quality Control

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

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

Supplement D - Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2 of the International Building Code must submit a *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project:

Fabricator's Name:

Address:

Certification or Approval Agency:

Certification Number:

Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the Contract Documents.

_____ _____
Signature Date

_____
Title

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

SECTION 01500

TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall provide all temporary facilities necessary for the proper completion of the Work, as necessary and as specified.

B. Maintain temporary facilities in proper and safe condition through the progress of the Work. In the event of loss or damage, immediately make all repairs and replacements necessary subject to approval of the Engineer and at no additional cost to City. At completion of the Work remove all such temporary facilities or as directed by the Engineer.

1.2 REQUIREMENTS

A. General
   1. The materials, equipment, and furnishings provided under this Section shall be new, and shall meet all the applicable codes and regulations.
   2. Make all provisions, and pay all costs of furnishing, installation, maintenance, professional services, permit fees, and site work for the temporary facilities.

B. Construction
   1. Temporary buildings shall be structurally sound, weather tight, with floors raised above ground. All mobile/modular buildings shall comply with GA-DCA/SBCC/ADA requirements, and shall be Williams-Scottsman or equal.
   2. Temporary buildings shall have temperature transmission resistance compatible with occupancy and storage requirements.

1.3 CONTRACTOR'S FACILITIES

A. Contractor's Facilities: Submit a plan of the Contractor’s facilities to Engineer for approval within 15 days of the Notice to Proceed. Contractor's facilities, for purposes of this Section, is defined to include but not limited to its field offices, first aid station, storage facilities, and laydown/staging areas. Sufficient construction facilities shall be provided and maintained at all points where work is in progress to meet adequately demands of the Work and with ample margin for emergencies or overload.

The facilities shall be of sufficient capacity and reliability to permit a rate of progress which will ensure completion of the Work within the time stipulated in the Contract.

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

B. First Aid Stations: Contractor shall provide a suitable first aid station. Each station shall be equipped with all facilities and medical supplies necessary to administer emergency first aid treatment. Contractor shall have standing arrangements for the removal and hospital treatment of any injured person. The information reflecting this arrangement shall be clearly posted for easy visibility. All first aid facilities and emergency ambulance service shall be made available by Contractor to City's personnel and its representatives.

1.4 TELEPHONE SERVICES

General

A. The Contractor shall provide all telephone services required for the proper completion of Contractor’s work.

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

1.5 PARKING FACILITIES

General

A. Provide ample parking, either graveled or paved, adjacent to Project Office, without necessitating jockeying of cars, for a minimum of 5 cars at the Project Office. The parking surfaces shall be promptly and adequately maintained by the Contractor for the duration of the Contract.

B. The parking facilities will be limited to the area(s) shown on the plans. The storage and work facilities provided by the City shall not be used for parking by the Contractor or its personnel. Additional parking facilities required by the Contractor shall be the Contractor's responsibility.

1.6 SECURITY AND MAINTENANCE

General

A. Provide periodic indoor and outdoor maintenance and cleaning for temporary structures, furnishings, equipment and services as specified herein above.

B. All offices shall be equipped with exterior security flood lights automatically activated by darkness and in sufficient number and placement to provide adequate lighting of the office and the parking areas.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

Fill and grade sites for temporary structures to provide surface drainage.

3.2 INSTALLATION

A. Construct temporary field offices, first aid stations, and storage facilities on proper foundations and provide connections for utility all services.

B. Locate construction office facilities at locations within the Project approved by the City Engineer.

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

D. Provide an outside standpipe equipped with a non-freeze hose bib at the Project Office. The hose bib is to be sized for a standard ½" garden hose connection.

3.3 MAINTENANCE AND CLEANING

Repair and clean the offices, parking areas and access routes and provide complete professional janitorial services, including toilet paper and paper towels, in the Project Office for the duration of the project. Cleaning shall be done on a daily basis, to the satisfaction of the City Engineer, during other than normal daytime office working hours. These services shall include sweeping, vacuuming, dusting, emptying of trash, cleaning of wash basins, bathroom and shower

facilities, daily mopping and monthly waxing of all vinyl floors. Contractor shall also provide for monthly exterminating services of the offices.

3.4 REMOVAL

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

B. Remove foundations and debris; grade site to required elevations; clean and restore areas to City Engineer's satisfaction.

END OF SECTION

SECTION 01520

SAFETY

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall be responsible for conducting all Work in a safe manner and shall take reasonable precautions to ensure the safety and protection of workers, property and the general public.

B. The Contractor shall comply fully with all applicable safety standards while conducting work on this project. These standards include all Federal and Local Occupational Safety and Health standards for General Industry (29 CFR Part 1910) and applicable standards in 29CFR Part 1926 for the Construction Industry.

C. The Contractor shall designate a trained and qualified employee who is to be responsible for ensuring that the Work is performed safely and in conformance with all applicable regulations.

D. The Contractor shall determine the safety hazards involved in completing the Work and the precautions necessary to conduct the Work safely.

E. The Contractor shall bear all risks associated with performing the Work and shall fully indemnify and hold harmless the City and Engineer.

F. Contractor shall use safety barriers such as safety cones or yellow caution tape where needed to indicate areas where work is in progress.

1.2 SUBMITTALS

A. The Contractor shall submit a copy of their current safety program.

B. OSHA 300 logs for previous 3 years prior to bid.

C. Confined space entry training records of employees before they are allowed to work in confined spaces.

D. All Confined Space Entry Permits completed during the project.

1.3 DEFINITIONS

A. Contract Personnel: Includes employees of the Contractor and any Subcontractors or other firms working on this Contract.

B. LEL: Lower Explosive Limit

C. Manager: The Facility Manager or his designee

D. OSHA: Occupational Safety and Health Administration

E. Work: Inclusive of all activities required to complete this task.

1.4 SPECIAL REQUIREMENTS

A. The Contractor's attention is directed to the fact that construction activities involving sanitary sewer systems will occasionally involve work in potentially hazardous environments in which oxygen deficient, toxic or explosive conditions may exist. Additional hazards arise from the presence of pathogens in the wastewater, from the slime and scum (coating walking, working and other surfaces), and naturally occurring animal and insect hazards such as snakes and mosquitoes. In dealing with these hazards, the Contractor shall take special precautions to ensure worker safety. Such precautions shall include, but are not limited to the following as applicable:

1. Installing temporary forced air ventilation equipment and ducts for fresh air in enclosed areas.
2. Using pneumatic tools and equipment instead of electric-driven equipment in hazardous areas.
3. Avoid the use of cutting torches, field welding and grinders in hazardous areas.
4. Cleaning and disinfecting working surfaces with hot water, high pressure washers prior to commencing work.
5. Providing portable oxygen meters, combustible gas detectors and hydrogen sulfide detectors to continuously monitor the atmosphere in enclosed working areas or when hot work is being performed.
6. Providing safety harnesses, safety lines and recovery crews for workers in hazardous areas.
7. All Exposed moving parts on equipment used shall be provided with guards which meet the requirements of OSHA. 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".
8. Providing dry chemical fire extinguishers and connected fire hoses in areas where a danger of fire or explosion exists.
9. Providing suitable wash-up areas and facilities for workers.
10. Installing temporary lighting using explosion-proof fixtures in hazardous environments.
11. Installing approved warning and hazard signs and posting safety procedures.
12. Instructing all workers as to the hazards present, the procedures to be followed and the proper function and use of all safety and emergency equipment furnished.

B. Prior to commencing Work on existing facilities and equipment, the Contractor shall notify the Manager and shall ensure that the source of electrical energy to all affected equipment is shutoff and locked out at the appropriate motor control center. Local switches and pushbutton stations, where provided, shall be locked in the "off" position.

C. Throughout the duration of the project, the Confined Space Entry form Permit (shown in Section 01520, Attachment A) must be completed each day and posted at the jobsite. Atmospheric monitoring of the confined spaces must be done prior to entry and whenever any employee enters a confined space. All expired permits must be maintained during the project and submitted to the City with any pay request.

D. For areas where safety handrails or channel grating are removed for repair, workers shall wear safety harnesses with a safety line. The area shall also be marked off with yellow caution tape and safety cones while work is in progress.

E. Contractor employees shall wear at a minimum safety glasses and steel toe shoes at all times while working at the facility. The Contractor's safety program may require additional personal protective equipment be worn.

F. Contractor shall verify that the conditions are safe before entering and beginning the Work. Provide additional safety improvements as needed to make the work space safe.

G. Contractor shall have personnel trained as entrants, attendants and rescue personnel following OSHA Confined Space Entry guidelines. Documentation of each employee's training records shall be submitted to the City prior to any entry of personnel into confined spaces. Personnel not having the appropriate training to enter confined spaces are not allowed to work in confined spaces. In addition, work in confined spaces will not be allowed without an attendant and standby rescue personnel available.

H. The Contractor shall maintain continuous atmospheric monitoring while personnel are inside confined spaces for oxygen levels, percent LEL, carbon monoxide, and hydrogen sulfide. Monitoring devices shall be equipped with alarms to automatically warn workers of the onset of dangerous atmospheric conditions. The Contractor shall have immediately available confined space rescue equipment and personnel certified in its use during times when personnel are working in confined spaces.

Attachment A

CONFINED SPACE ENTRY PERMIT

(THIS PERMIT MUST BE POSTED AT JOB SITE) **Tracking Number:** _ _ _ _ _ _ _ _ _ _

Confined Space to be Entered: _____ Work Order #_____ Date_____

Location: _____ Permit Expiration Date/Entry Time: _____

Description of Work to be Performed:

_____

NATURE OF HAZARDS IN CONFINED SPACE: (CHECK)

_____ Oxygen deficiency (Less than 19.5% at sea level)

_____ Flammable gases or vapors (greater than 10% of the lower flammable limit, or greater than 23.5% oxygen at sea level)

_____ Toxic gases or vapors (greater than the permissible exposure limit)

_____ Mechanical hazards

_____ Electrical shock

_____ Materials harmful to the skin

_____ Engulfment

_____ Other _____

PREPARATION: (check)

_____ Notify affected department of service interruption

_____ Isolate – blanked or double valve, with lock and tag

_____ Zero energy state (Lock Out all energy sources)

_____ Cleaned, drained, washed and purged

_____ Grounding and bonding wire in place

_____ Ventilation equipment to provide fresh air in use

_____ Procedures reviewed with each employee

_____ Atmospheric test in compliance

_____ Employees informed of specific confined space hazards

_____ Attach hot work permit

_____ Emergency response team available

_____ Other _____

Entry Supervisor_____

EQUIPMENT REQUIRED FOR ENTRY AND WORK: (CHECK)

_____ Respirator: Airline, Air Supplied w/Egress, SCBA, Air Purifying, Cartridge type, Disposal Brand

_____ Fall Protection Equipment: Full Body Harness w/"D" Ring and lifeline

_____ Protective Clothing: Safety glasses, chemical goggles, face shield, safety glasses, hard hat, safety shoes, rubber boots, gloves

_____ Protective clothing: Cotton Coveralls, Tyvek suit, coated Tyvek suit, other

_____ Hearing protection

_____ Other_____

Respiratory Protection (specify)_____

Communication aid (specify)_____

Rescue equipment (specify)_____

Electrical equipment/tools:

_____ Low voltage

_____ Ground-fault current interrupters

_____ Approved for hazardous location

_____ All electrical equipment listed Class 1, Division 1, Group D and non-sparking tools

AUTHORIZED ENTRANTS:

_____

_____

_____

AUTHORIZED ATTENDANTS:

_____

_____

_____

Confined Space Permit
Revised May 31, 2000

Test	Allowable Limits	Check (√) If required	Result	Result	Result	Result	Result	Result
Time			____:____	____:____	____:____	____:____	____:____	____:____
Oxygen-min.	19.5%							
Oxygen-max.	23.5%							
Flammability	10% LEL							
H_2S	10 ppm							
Toxic (specify)								
Cl_2	.5 ppm							
ClO_2	.1 ppm							
SO_2	.2 ppm							
Heat	°F/°C							
Other								
Other								

Name of employee conducting atmospheric monitoring: _____

Instrumentation (Serial #/Calibration Date): _____

RETEST AFTER VENTILATION, BUT PRIOR TO ENTRY (PERIODICALLY AS APPROPRIATE)

IF HAZARD IS DETECTED: LEAVE THE CONFINED SPACE. REEVALUATE THE SITE. CORRECT ANY PROBLEMS.

Authorization:
I certify that all required precautions have been taken and necessary Equipment is provided for safe entry and work in this confined space.

Name (Print):_____

Time: _____ Date: _____ Signature_____

Confined Space Permit
Revised May 31, 2000

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01540

SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SECURITY PROGRAM

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

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

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

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

E. The Contractor shall provide the City Engineer with a list of 24 hour emergency phone numbers including chain of command.

1.2 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 City upon request. This log shall be submitted to the City Engineer bi-weekly or as necessary.

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

E. The Contractor shall require all employees to sign the Employee Acknowledgment of Project Site Rules Log included at the end of this Section. All employees, subcontractor employees and lower tier contractor employees will receive a new employee orientation. Signing the Employee Log by the employee is certifying that the orientation training has been received.

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

1.3 BARRICADES, LIGHTS AND SIGNALS

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 will be visible at night. From sunset to sunrise, the Contractor shall furnish and maintain at least one light at each barricade and sufficient numbers of barricades shall be erected to keep vehicles from being driven on or into any work under construction.

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

1.4 RESTRICTIONS

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

1.5 CONTRACTOR SAFETY/HEALTH AND SECURITY PLAN

A. Prior to the performance of any work the Contractor will prepare a contract specific Safety/Health and Security Plan signed by an officer of the Contractor's organization. Adequacy is the responsibility of the Contractor. The plan shall include site specific elements for each work site.

B. The Contractor's safety plan will not be reviewed for the adequacy of the plan. The plan shall:
   1. Identify the person(s) responsible for implementation and enforcement of Safety/Health and Security rules and regulations for this Project.
   2. Generally address safe work procedures for the activities within the Contractor's scope of work.
   3. Include a new employee orientation program, which addresses job and site specific rules, regulations and hazards.
   4. Include the Contractor's Drug Free Work Place Policy including substance abuse prevention and testing program.

5. Include provisions to protect all of the Contractor's employees, other persons and organizations who may be affected by the work from injury, damage or loss.
6. Comply with current Fed/OSHA, Safety/Health and Security Plan, 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 City Engineer with documentation to show compliance with their plan, plus accidents and investigation reports.
11. Address any other contract specific requirement, including the, Unique Requirements of these specifications.

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

D. Review of the Contractor's Safety Plan by the City Engineer shall not impose any duty or responsibility upon the City Engineer 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 City Engineer with all safety reports, training records, competent person list, and accident reports prepared in compliance with Fed/OSHA and the Project Safety/Health and Security Plan.

1.6 PROJECT SAFETY COORDINATOR

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

B. The Project Safety Coordinator shall:
1. Ensure compliance with all applicable health and safety requirements of all governing legislation.
2. Schedule and conduct safety meetings and safety training programs as required by law for all personnel engaged in the work.

3. Post all appropriate notices regarding safety and health regulations at locations that afford maximum exposure to all personnel at the job site.
4. Post the name, addresses, and hours of the nearest medical doctor; names and addresses of nearby clinics and hospitals; and the telephone numbers of the fire and police departments.
5. Post appropriate instructions and warning signs with regard to all 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 savers, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, explosion meters, and any other equipment mandated by law.
7. Make inspections at least once daily in accordance with an inspection checklist report form to ensure that all machines, tools and equipment are in safe operating condition; that all work methods are not dangerous; and that all work methods are free of hazards.
8. Submit to the City Engineer upon request copies of all inspection checklist report forms, safety records and all safety inspection reports and certifications from regulating agencies and insurance companies.
9. Notify City Engineer of a serious accident immediately, followed by a detailed written report within twenty-four (24) hours. "Serious accident" is defined as that requiring an absence of work of more than 2 days and/or hospitalization.
10. Notify the City Engineer immediately in the event of a fatal accident.
11. Notify Engineer of any accident claim against the Contractor or any sub-contractor immediately, followed up by a detailed written report on the claim and its resolution.
12. Review safety aspects of the Contractor's submittals as applicable.

1.7 ACKNOWLEDGMENT OF THE PROJECT SITE RULES

The acknowledgements below shall be included as part of the visitor and employee sign-in logs. No access to the site shall be permitted without acknowledgement of the Project Site Rules.

VISITOR ACKNOWLEDGEMENT OF THE PROJECT SITE RULES

By signing this Visitor's Log, I acknowledge that I understand and agree to abide by the project rules outlined below.

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

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

PROHIBITED ACTIVITIES

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

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

VISITOR LOG

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

VISITOR'S NAME PRINT	SIGNATURE	COMPANY VISITED	DATE	IN	OUT

EMPLOYEE ACKNOWLEDGMENT OF THE PROJECT SITE RULES

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

PROHIBITED ACTIVITIES

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

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

EMPLOYEE LOG

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

EMPLOYEES (PRINT)	SIGNATURE	COMPANY NAME	DATE

END OF SECTION

SECTION 01550

TRAFFIC REGULATIONS

PART 1 - GENERAL

1.1 SCOPE

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

1.2 TRAFFIC CONTROL MANAGER REQUIREMENTS

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

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

PART 2 - PRODUCTS

2.1 SIGNS, SIGNALS, AND DEVICES

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

B. The Contractor shall provide automatic traffic control signals as approved by local jurisdictions.

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

D. The Contractor shall provide flagmen equipment as required by local jurisdictions.

PART 3 - EXECUTION

3.1 PERMITS

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

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

C. Full street closures permits require ninety-six (96) hours advance notice prior to road closure. The following additional information is required prior to approval:
   1. The recommended detour route with signage and Traffic Management Plan as per the Manual of Uniform Traffic Control Devices (MUTCD).
   2. A copy of the resident and/or business notification letters about the closure. The residents/businesses located between the detour route must be notified about the closure at least five (5) business days prior to the proposed closure.

D. The City of Atlanta Division of Traffic and Transportation will return full road closure permit applications to the Contractor with a cover letter to the Fire Chief, Chief of Police, Grady Memorial Hospital, MARTA, and the Atlanta Board of Education. The Contractor shall have received the

permit application and cover letter at least seventy-two (72) hours before commencing road closure activities.

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

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

3.2 PREPARATION OF TRAFFIC CONTROL PLANS

In accordance with the specifications, permitting agencies, and the MUTCD, the Contractor shall develop detailed staging and traffic control plans for performing specific areas of the Work including but not limited to all requirements for certified flagmen, additional traffic control devices, traffic shifts, detours, paces, lane closures or other activities that disrupt traffic flow. The Contractor shall submit these plans in accordance with the Specifications to receive final approvals from permitting agencies and provide any and all required traffic control devices as required by both the permitting agencies and these specifications at no additional cost to the City.

3.3 CONSTRUCTION PARKING CONTROL

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

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

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

3.4 MAINTENANCE OF TRAFFIC

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

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

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

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

3.5 UNIFORMED POLICE OFFICER FOR TRAFFIC CONTROL

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

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

C. Officers will be employed and paid by the Contractor.

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

3.6 FLAGMEN

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

3.7 FLASHING LIGHTS

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

3.8 HAUL ROUTES

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

B. The Contractor shall confine construction traffic to designated haul routes.

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

3.9 ROAD CLOSURES ON CITY ROADS

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

B. To obtain approval to close a road or street maintained by the City, the Contractor must proceed as follows:
   1. The Contractor must obtain approval of his traffic plan from the City Engineer. The traffic plan must be in accordance with the requirements of the Georgia Department of Transportation and the City of Atlanta.
   2. The Contractor must obtain a utility permit.
   3. The Contractor must apply in writing to the City and obtain a permit to close the road on a specific date. Routine permit approval by the City requires from one (1) to two (2) weeks depending on when the application is received.
   4. The Contractor must obtain a permit from the City before posting closure signs. Signs must be posted for seven (7) days prior to the first day of closure. Signs must be acceptable to the Engineer.
   5. Emergency road closures will be handled by the City Engineer.

3.10 PROCEDURES FOR TRAFFIC DETOUR ROUTE PLAN

A. The Contractor shall provide a sketch map showing his traffic detour route plan to the City Engineer. The sketch map need not be drawn to scale but should resemble, as closely as possible, the actual location. The sketch map shall be drawn in a manner so as to provide emergency agencies a better understanding of the detour for quick response. The sketch map shall include directional arrows showing the flow of traffic.

B. "Road Closed Ahead" signs shall be erected before the start point of the detour indicating the name of the street closed.

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

D. The Contractor shall erect an "End Detour" sign at the end of the detour.

E. Each detour and "End Detour" sign shall be accompanied by an accessory plate indicating the name of the street being detoured.

F. The Contractor shall apply appropriate traffic control measures in accordance with the requirements of the MUTCD and the City of Atlanta codes.

3.11 BARRICADES AND WARNING SIGNS

A. The Contractor shall furnish, erect, and maintain all barricades and warning signs for hazards necessary to protect the public and the Work. When used during periods of darkness, such barricades, warning signs and hazard markings shall be suitably illuminated or reflectorized.

B. For vehicular and pedestrian traffic, the Contractor shall furnish, erect, and maintain barricades, warning signs, lights, and other traffic control devices in conformity with the requirements of the Georgia Department of Transportation and the City of Atlanta.

C. The Contractor shall furnish and erect all barricades and warning signs for hazards prior to commencing Work which requires such erection and shall maintain the barricades and warning signs for hazards until their dismantling is directed by the Engineer.

3.12 REMOVAL

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

END OF SECTION

SECTION 01600

GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. All installed materials and equipment are to be the latest version of the manufacturers product line and not be outdated by newer versions at the time of purchasing. Materials and equipment, which show any signs of extended storage such as corrosion, scratches and dents, will not be accepted for installation in this project.

B. All equipment used for performing the Work shall conform to the latest version of all applicable safety standards including but not limited to OSHA requirements. Contractor shall not exceed or ignore any requirements or recommendations of the equipment manufacturer. Equipment not meeting requirements of this Section will be barred from use on the project.

C. All installed material and equipment shall meet or exceed the latest applicable code requirements including but not limited to, Underwriters Laboratory, Standard Building Code and OSHA, as well as requirements of these Specifications. Where there is conflict with requirements of the Contract Documents and code requirements, comply with the more stringent requirements with no additional compensation to the Contractor.

PART 2 - MATERIALS AND EQUIPMENT

2.1 ANCHOR BOLTS

A. All anchor bolts to be ANSI type 316 stainless steel unless otherwise specified or indicated, and must conform to requirements of this Section and the material articles in the appropriate Sections they are used.

B. All anchor bolts are to be 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. Determine design loads as follows:
      a. For equipment anchors, use the design load recommended by the manufacturer and approved by the Engineer.

b. For pipe hangers and supports, use one half the total weight of pipe, fittings, valves, accessories and water contained in pipe, between the hanger or support in question and adjacent hangers and supports on both sides.

c. Allowances for vibration are included in the safety factor specified above.

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
½	4,500	6,300
⅝	6,900	7,700
¾	10,500	9,900

3. Embedment depth to be 6 inches for epoxy anchors unless noted otherwise on the drawings. Expansion anchors shall be embedded sufficiently to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete but a minimum of 4 inches, 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 Speed Bond #1 epoxy injection as manufactured by Prime Resins, Inc. or equal.
2. For all other applications, provide ANSI type 316 steel expansion anchors from one of the following manufacturers.
3. Hilti, Incorporated.
4. Ramset, Incorporated.
5. Or equal.
6. Install anchors per manufacturer's recommendations and this Section.
   Drilled anchorage holes are to be blown out with compressed air before installing anchor.

2.2 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. All threads shall be clean cut and shall conform to AN Standard B1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).

2.3 CONCRETE INSERTS

Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type, which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized, then epoxy phenolic primed and top coated with PVC, using thermal bond process.

2.4 ELECTRICAL EQUIPMENT ENCLOSURES

All items of electrical equipment that are furnished with process equipment shall conform to the requirements specified under the appropriate electrical sections of the specifications. Enclosures for electrical equipment such as switches, starters, etc., shall conform to the requirements specified under the appropriate electrical sections of the specifications.

2.5 EQUIPMENT DRIVE GUARDS

All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism, unless otherwise indicated on the Drawings or relevant equipment specification. Guards shall be constructed of epoxy paint coated, galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps, which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

2.6 NAMEPLATES

A. Each piece of equipment shall be provided with a substantial nameplate of non-corrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.

B. This requirement shall not apply to standard, manually operated gate, globe, butterfly, diaphragm, ball, and plug valves.

C. Each process valve shall be provided with a substantial tag of corrosion resistant metal securely fastened in place and inscribed with an identification number in conformance with the tag numbers indicated on the Process and Instrumentation Drawings.

2.7 LUBRICANTS

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

2.8 PROTECTION AGAINST ELECTROLYSIS

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

2.9 TRANSPORTATION, HANDLING, STORAGE AND PROTECTION

A. Packing and Shipping:

1. Product and materials shall be shipped and handled in ways which will 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 will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Engineer.
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 ensure 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. 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.

2.10 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, which supplier shall provide all components of the system to enhance compatibility, ease of construction, and efficient maintenance. The Contractor shall be responsible to the City for performance of all system in accordance with the provisions of the General Conditions of the Contract Documents.

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. A typical Manufacturer's Certificate of Unit Responsibility form is included in this specification.

2.11 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Where manufacturers' services are specified, Contractor shall furnish an authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system to perform these services. Additional qualifications of the manufacturer’s representative may be specified elsewhere. Where time is necessary in excess of that stated in the Specifications for the manufacturers' service representative to complete the specified services, the additional time required to perform the services shall be considered incidental work for which the Contractor will receive no additional compensation.

B. After installation of the listed equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the representative shall inspect, operate, test and adjust the equipment. The inspection shall include, but shall not be limited to, the following points as applicable:
   1. Soundness (without cracked or otherwise damaged parts).
   2. Completeness in all details, as specified.
   3. Correctness of setting, alignment, and relative arrangement of various parts.
   4. Adequacy and correctness of packing, sealing and lubricants.

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. On completion of its work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer Certificate Submittals in accordance with sub-paragraph L of this paragraph and a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

E. After the Engineer has reviewed the reports from the manufacturers' representative, the Contractor shall make arrangements to have the manufacturers' representatives present when the field acceptance tests are made.

F. Requirements of this paragraph will be in addition to those of appropriate equipment and material Sections.

G. Fulfillment of Specified Minimum Services
   1. Only those manufacturers' services, including trips to the jobsite or training classroom, receiving prior written acceptance or authorization by the Engineer shall act to fulfill the specified services.
   2. If manufacturer's representative is found deficient in training or experience by the Engineer, furnish other acceptable representatives after acceptance of resumes and other documentation of proposed representatives.

H. Proper Installation of Products and Systems

Furnish manufacturers' representatives of products and systems. Representatives shall resolve assembly or installation problems attributable to, or associated with, their products and systems, whether or not specifically required in the Specifications.

I. Functional Testing

1. Where functional (or run) testing is required in the Specifications, furnish manufacturer's representative to assist with the test. This shall include checking for proper rotation, alignment, speed, excessive vibration, and quiet operation. Perform initial equipment and system adjustment and calibrations in the presence and with the assistance of the manufacturer's representative.
2. Obtain manufacturer's review and acceptance of Contractor's certification of functional testing, where such certification is specified.

J. Performance Testing

1. Where performance testing is specified, furnish manufacturer's representative to assist the test as specified for the particular equipment, and to correct malfunction of equipment. Follow specified test procedures.
2. These services shall continue until:
    a. Equipment or systems have been successfully tested for performance.
    b. Performance test report has been reviewed and accepted.
    c. Equipment or systems have been accepted by Engineer for startup.
3. Unless otherwise specified, performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions.

K. Training of City's Personnel

1. Additional training requirements are specified in Section 01664, Training, and individual equipment specifications.
2. Designate and provide Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Engineer and shall be familiar with the Operation and Maintenance (O & M) Manual information specified in the General Conditions of the Contract Documents.
3. Training services shall be performed by an approved manufacturer’s representative and shall include pre-startup classroom instruction, post startup classroom instruction, and onsite equipment instruction, as stated in the Specifications.
4. Pre-startup Training: Coordinate pre-startup training periods with Owner's operating personnel and manufacturers' representatives, and with submittal of O & M Manuals.

a. Pre-startup training shall be completed at least 14 days prior to actual startup.
b. O & M Manuals shall be reviewed, accepted, and resubmitted, in accordance with Section SUBMITTALS, before startup.

5. Post Startup Training: Where post startup training is required in the Specifications, furnish and coordinate the specified manufacturers' services and Contractor's personnel for post startup training of Owner's operating personnel.

L. Certificate Submittals

The forms included with this Section are to be used by the Contractor and by manufacturers of systems and products to certify proper installation, completion of functional testing, and performance testing results.

MANUFACTURER'S CERTIFICATE
OF
PROPER INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation recommendations and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Equipment serviced with proper lubricants.			
All safety equipment properly installed.			
Proper electrical connections.			
Proper mechanical connections.			
Equipment meets all warranty requirements.			

List additional items checked: (See Detailed Specification Section)

_____

_____

_____

Comments: _____

_____

_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____
Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
FUNCTIONAL TEST ACCEPTANCE INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation, that proper adjustments have been made, that the equipment or system is ready for plant startup and operation and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Rotation			
Alignment			
Speed			
Noise level			
Initial adjustments			
Initial calibration			

List additional items checked: (See Detailed Specification Section)

_____

_____

Comments: _____

_____

_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____
Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
PERFORMANCE TEST ACCEPTANCE

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To certify that the equipment or system identified above has been successfully tested for performance and is ready to be accepted by the City for full-time operation.

This certifies that the above equipment or system operated under actual performance conditions, and that the equipment or system meets the specified performance criteria.

Comments: _____
_____
_____
_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

Engineer: _____ Date: _____

CONTRACTOR'S CERTIFICATE
OF
EQUIPMENT START-UP READINESS

Contractor: _____

Equipment Name(s): _____

_____

_____

Equipment Tag Number(s): _____

_____

_____

Specification Section: _____

"I, the undersigned, do hereby certify that all of the necessary hydraulic structures, piping systems, and valves have been successfully tested; that all necessary equipment systems and subsystems have been checked for proper installation, started. and successfully tested to indicate that they are all operational; that the systems and subsystems are capable of performing their intended functions; and that the facilities noted above are ready for startup and intended operation."

_____ _____

Signature Title Date

MANUFACTURER'S CERTIFICATE
OF
UNIT RESPONSIBILITY

Manufacturer: _____

Equipment Name: _____

Specification Section(s):_____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Purpose: To certify that the equipment or system manufacturer identified above accepts unit responsibility for equipment or systems furnished.

This certifies that the above equipment or system manufacturer accepts unit responsibility for equipment or systems furnished under the indicated specification section(s) and that the components furnished are compatible and comprise a functional unit suitable for the specified performance and design requirements.

Signatures (Do not initial.)

Contractor: _____ Date: _____

Manufacturer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
INSTRUCTION CERTIFICATION

Contract No.:

Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment Item: _____

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

Operations Check List (check appropriate spaces)

Startup procedure reviewed_____
Shutdown procedure reviewed_____
Normal operation procedure reviewed_____

Others: _____
_____
_____

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency)_____
Described special tools required_____
Described normal items to be reviewed for wear_____
Described preventive maintenance instructions_____
Described greasing frequency_____

Others: _____
_____
_____

Date	Manufacturer
Date	Signature of Authorized Representative
Date	Signature of City's Representative
Date	Signature of Contractor's Representative

END OF SECTION

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SECTION 01610

TRANSPORTATION AND HANDLING

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall provide transportation of all equipment, materials and products furnished under these Contract Documents to the Work site. In addition, the Contractor shall provide preparation for shipment, loading, unloading, handling and preparation for installation and all other work and incidental items necessary or convenient to the Contractor for the satisfactory prosecution and completion of the Work.

B. All equipment, materials and products damaged during transportation or handling shall be repaired or replaced by the Contractor at no additional cost to the City prior to being incorporated into the Work.

1.2 TRANSPORTATION

A. All 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 ensure that the weights of the assembled sections do not exceed the capacity of the cranes or hoisting equipment.

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

1.3 HANDLING

A. All 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 padded as required to prevent damage to protective coatings and finishes.

END OF SECTION

SECTION 01650

FACILITY STARTUP

PART 1 - GENERAL

1.1 RELATED SECTIONS (RESERVED)

1.2 DEFINITIONS

A. Pre-Operational Checkout (Step 1): Are those documented physical checks (tests) that must occur to ensure that an item of equipment or equipment system is ready for functional testing. Example components of pre-operational checkout /testing include but are not limited to the following:

1. Pressure and/or leakage tests, water-tightness of concrete structures, and pipe testing.
2. Electrical testing, resistance testing in accordance with NETA - section 16T. Also, Phase/motor rotation checks.
3. Instrument calibration and loop tests. Pre-operational check-out of instrumentation system controls.
4. Pre-operational checkout of mechanical and HVAC equipment to include alignment, lubrication, and other checks as recommended by the manufacturer.

B. Functional Test: (Step 2): A test or tests, in the presence of the City and/or the City's Engineer, to demonstrate that the installed equipment or system meets manufacturer's installation and adjustment requirements and other requirements.

The testing of the individual items of equipment within a system will be performed under simulated conditions to determine contract compliance. This test will utilize plant effluent, potable water, or another acceptable substitute test media. The equipment will be operated long enough to gather information (data) on noise, temperature, vibration, performance characteristics, and to make initial adjustments of any applicable controls. Initial baseline data will be gathered on equipment with motors greater than 1 horsepower including amperage, bearing temperatures, and vibration.

The instrumentation and control field testing (loop checks from the field devices to PLC or distributed control systems as well as field calibrations) will be accomplished during the pre-operational checkout and functional testing stages as defined above.

C. Operational Test (Step 3): A test, performed in the presence of the City and/or the City's Engineer, of all components within a system collectively to ensure that the system and all of its integral components function as

intended. Water and/or other temporary media supplied by the Contractor will be circulated through the completed facility/system for 5 days with systems being operated under various loading conditions as proposed by the Contractor and approved by the City's Engineer.

The instrumentation and control system automatic function for the overall system will be verified and documented during the operational testing stage as described above.

D. Punchlist: All items that could affect, or be affected by, the full-time operation of the system (as deemed critical by the City Engineer) must be complete prior to the Operational Test phase.

E. Acceptance Test (Step 4): The start-up and operation of the systems installed, under actual operating conditions, as part of the actual plant process. The acceptance test period is 30 days. The City's O&M staff will be responsible for running the system with the Contractor's support team being available for assistance 24/7. Upon completion of this commissioning period the Contractor may apply for a Substantial Completion certificate.

F. Performance Test: Any special tests, performed in the presence of the City and/or the City's Engineer, called for by the specific equipment or system specification which are to be performed in addition to the installation and acceptance tests noted in this start-up specification (pre-operational checkout, functional testing, operational testing, and acceptance testing).

G. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this Project are as follows:
   1. Pumps, motors, and controls.
   2. Instrumentation and control system(s).

H. Substantial Completion: The date certified by the City Engineer when all or a part of the work has been properly installed per the contract documents and manufacturer recommendations, deemed operational through the completion of the Pre-operational checkout, Functional Test, Operational Test, has all test documents with Operation and Maintenance manuals delivered, is sufficiently completed in accordance with the requirements of the Contract Documents and has been demonstrated through the 30 day Acceptance Test thus proving that the identified portion of the work can reliably be utilized for the purposes for which it is intended.

1.3 SUBMITTALS

A. Administrative Submittals:
   1. Functional and performance test schedules and plan for equipment, units, and systems at least 14 days prior to start of related testing. Include test plan, procedures, and log format.
   2. Schedule and plan of facility startup activities at least 21 days prior to commencement.

B. Quality Control Submittals:
   1. Manufacturer's Certificate of Proper Installation as required.
   2. Test Reports: Functional and performance testing, in format acceptable to the City Engineer and certification of functional and performance test for each piece of equipment or system specified.
   3. Certifications of Calibration: Testing equipment.

1.4 CONTRACTOR FACILITY STARTUP RESPONSIBILITIES

A. General:
   1. The Contractor shall provide, at no expense to the City, all power, fuel, compressed air supplies, water, and chemicals; as well as all labor, temporary piping, heating, ventilating, and air conditioning or bypass pumping, for any areas where the Improved Facilities are not complete and operable at the time of Acceptance Testing and its prerequisites. Contractor shall provide all other items and work required to complete Acceptance Testing and its prerequisites. Temporary facilities shall be maintained until permanent systems are in service.
   2. The Contractor shall also provide all necessary qualified operations personnel and manufacturers field service personnel of the major equipment suppliers on an eight hour per day basis at the facilities and on a 24 hour per day basis locally during the operational and acceptance test period.
   3. At no time during startup shall the Contractor allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

B. Tie-Ins or Modifications to The Existing Systems
   1. Anytime the Contractor ties into or modifies an existing system, a detailed work plan shall be required. Submittal of this work plan must be a minimum of 30 days in advance of commencement of the subject work. This work plan shall include a detailed description of the work, a step-by-step plan of the modification or tie-in, a detailed timeline schedule, a detailed list of materials and equipment required, demonstrated communications capacity, and a listing of any gates or valves which must be operated. Working

drawings shall be submitted as required under GC-28 for any permanent or temporary structural modifications. A temporary safety plan covering the period of the work, and a listing of contingency plans and supplies, including but not limited to spill prevention planning and spill containment kits, shall be required. A coordination meeting with the City's plant operating staff, the Contractor and any parties so designated by the City must be held at least 7 days prior to the commencement of the modification or tie-in. The day before the commencement of the modification or tie-in, a final coordination meeting shall be held giving final detailed work assignments to all parties involved.

2. The City has the right to require, at no additional cost to the City, stand-by equipment on any item(s) deemed critical enough to delay the work. The Contractor shall have available stand-by personnel to supplement the committed forces should problems arise. The Contractor is responsible for meeting all OSHA standards including entrance and exit safety, confined space entry, fall protection, scaffolding, rigging, etc.

C. Contractor's Startup Quality Assurance Manager

The Contractor shall appoint an operations engineer or equally qualified operations specialist as Startup Manager to manage, coordinate, and supervise all aspects of the Contractor's startup and testing program including, but not limited to those components of the program as listed with this appendix. The Startup Manager shall have at least five (5) years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical, civil or a related program of study. Operations specialists shall have equivalent documented experience in plant operation and maintenance. Contractor shall submit the Startup Manager's resume for review and approval a minimum of six months prior to any testing, or prior to 50% completion of the first constructed system.

D. Contractor's Testing Team

1. Contractor's Testing Team shall include at a minimum the Quality Assurance Manager, qualified Mechanical/Equipment Foreman, qualified Electrical Journeyman, qualified Instrument Technician, and qualified/Certified Plant Operations personnel.
2. Contractor is responsible to have the appropriate personnel, procedures, and test forms at the test site when performing a scheduled checkout/testing activity that is to be witnessed by the City Engineer.

E. Test Equipment

1. All test equipment (gauges, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus two (2) percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.
2. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.
3. Calibration equipment/test instruments utilized for start-up and testing shall be documented to include identification (by make, manufacturer, model, and serial number) of the test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory as well as documentation of current calibration.
4. All analysis instruments, sensors, gauges, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration prior to Acceptance.
5. Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.

1.5 OWNER/ENGINEER FACILITY STARTUP RESPONSIBILITIES

A. General:

1. Review Contractor's test plan and schedule.
2. Witness each functional, operational (portions of) and performance test.
3. Coordinate other plant operations, if necessary, to facilitate Contractor's tests.

B. Startup Test Period:

1. Operate process units and devices, with support of Contractor.

2. Provide sampling, labor, and materials as required and provide laboratory analyses.
3. Make available spare parts and special tools and operation and maintenance information for Owner-furnished equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - PART 3 – EXECUTION

3.1 START-UP PROGRAM IMPLEMENTATION

A. Start-Up Meetings

1. The Contractor shall schedule and conduct regular periodic start-up meetings (separate from regular progress meetings). The start-up meetings will be held at least every 10 days (once start-up planning commences) and may be scheduled at a more frequent interval by the City Engineer if necessary. Start-up meetings shall be held at a location designated by the Contractor and approved by the City Engineer.
2. Start-up meetings shall be attended by the City Engineer, Contractor, Subcontractors as appropriate to the agenda, suppliers as appropriate to the agenda and others as required.
3. The meeting agenda shall generally include review and approval of minutes of previous meeting, review of start-up progress since the previous meeting, field observations, problems, and conflicts, problems which impede Start-Up Schedule, delivery schedules, corrective measures and procedures to regain the start-up schedule, revisions to Start-Up Schedule, progress and schedule of the preceding work period, coordination of schedules, review of start-up submittal schedules and status, status of start-up related requests for information, and any other business deemed appropriate.

B. Start-up and Testing Schedule

1. The Contractor shall produce an overall testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Construction Schedule. The testing schedule shall show the contemplated start date, duration of the test and completion of each test.
2. The preliminary test schedule shall be submitted with the overall Start-up Acceptance Test Plan. The City Engineer will not witness any testing work until the Contractor has submitted a schedule to which the City Engineer takes no exception. The test schedule shall be updated weekly, and presented at each start-up meeting, showing actual dates of test work, indicating systems and

equipment testing completed satisfactorily and meeting the requirements of the Contract Standards, and also re-forecast the upcoming testing and reflect any schedule adjustments accompanied by written reason for the change. The Contractors baseline start-up and testing schedule is to be submitted with the overall test plan.

C. Documentation

1. The Contractor shall develop a records-keeping system to document all activities associated with Acceptance Testing and its prerequisites.
2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test and signature spaces for witness by the City Engineer, the Contractor's Start-Up/Quality Assurance Manager, and the Equipment Manufacturer. A separate file shall be established for each system, organized by start-up phase (i.e., pre-operational, functional, operational, acceptance test phase), and will include sections for each item of equipment. These files shall include the following information and documentation as a minimum. Test plan and documentation organization shall be as follows:

D. Test Plan Organization

1. Index.
2. Schedule
3. Step 1 & 2: Each type of equipment will have its own section within the system and include the following:
    a. The detailed pre-operational test procedures.
    b. The detailed functional test procedures.
    c. Customized mechanical equipment, customized electrical, and customized instrumentation pre-operational and functional test forms as applicable.
    d. Other pre-operational test documentation as required for piping and mechanical equipment.
4. Step 3: A separate section will be created for the system operational testing and include the following:
    a. The detailed 5 day operational test procedure.
    b. A detailed operational system check/sign-off sheet (based on system tests, control checks, and interlock checks to be performed).
    c. System operational test completion sign-off form.
5. Step 4: Another section is to be designated for the Acceptance Testing and include the following:
    a. Detailed work plans, communications plan, safety plan, and contingencies, as well as other requirements outlined under tie-ins and modifications to existing systems (SC-24).

b. 30-day test overview and proposed spreadsheet forms to be utilized by the Contractors staff to record appropriate operational and performance data on a regular interval for the 30 days.

c. System acceptance test completion/sign-off form.

6. The forms attached to this Appendix are samples showing the required format and level of detail for documentation. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable example documentation forms for all systems and items of equipment shall be produced and submitted for review and approval by the City Engineer as a condition precedent to the Contractor's receipt of progress payments in excess of 60 percent of the contract amount. Once the City Engineer has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce customized forms for each item of equipment and system and include these individual forms in the overall test plan that will be submitted for approval.

7. The complete test plan and all its sections are to be submitted (60 days prior to any testing) and approved, Code 1 or Code 1C, prior to the start of any testing.

3.2 TEST PLAN IMPLEMENTATION

This program will be implemented in 4 distinct steps (phases). These steps are the Pre-Operational Checkout, the Functional Testing, the Operational Testing, and the Acceptance Testing.

3.3 STEP 1 - PRE-OPERATIONAL CHECKOUT AND TESTING

A. The first step involves the Pre-operational checkout. This would include multi-discipline work completion and physical checkout. The Pre-operational Completion Verification and Pre-operational test reports include the following required testing. Examples of these documented tests include, but are not limited to:

1. Field pressure/leakage test reports for all pipe, valves, and appurtenances.
2. Wire insulation megohm reports for all 120V and greater wire.
3. Phasing, ratio, polarity, ground resistance, current injection, insulation resistance, over potential test, and circuit breaker contact resistance reports for medium voltage switchgear.
4. Insulation power factor and resistance test reports for surge arresters.

5. Megger reports for Unit Substations, Three Winding Transformers, and 4160V motor control centers.
6. Megger reports and ground connection tests.
7. Loop Status Report and Component Calibration forms.
8. Equipment installation checkout forms.

B. Pipe Testing

1. Prior to application of insulation on exposed piping, test the piping systems at the appropriate pressure according to the requirements of related piping specifications. All buried piping shall be tested prior to any backfill being placed, unless prior approval by the City Engineer is given in writing. Test duration shall be one-hundred twenty (120) minutes for all tests and witnessed by a City Engineer. Isolate equipment that may be damaged by the specified test conditions. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Testing shall include existing piping systems that connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping that fails the test shall be repaired.
2. For gas, air, and vapor systems, the allowable leakage rate for systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas and natural gas systems. Testing medium shall be as follows for gas, air, and vapor systems:

Pipeline size	**Specified test pressure**	**Testing medium**
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

3. For liquid systems, leakage shall be zero at the specified test pressure throughout the specified duration for exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping. Drain systems, other than pumped drain

systems, shall be tested in accordance with Georgia State Minimum Standards.

4. For hydraulic and lube oil systems, upon completion of cleaning, all field connections shall be completed, and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period. For fluid power systems, the manufacturer shall supervise the installation and testing of all system components including all field piping.

C. Pipe System Cleaning and Flushing

1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping 24 inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

2. Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs that remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	**Maximum screen opening, inches**
0 to 1	1/16
1-1/4 to 3	1/4
3-1/2 to 6	1/2
Over 6	1

3. The Contractor shall maintain the screens during all testing prior to the start of Acceptance testing. In special cases, screens may be removed as required for performance tests. Prior to the start of Acceptance Testing, the Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Systems handling solids are exempted.

4. Gas and air system piping 6 inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than 6 inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon

completion of cleaning, the piping shall be drained and dried with an air stream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psig until the piping is placed in service.

5. After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the piping system using connected equipment for a minimum period of 15 minutes and until no debris is collected on the screens. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.
6. Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide certificate of compliance that the ACL has been met.

D. Equipment – Pre-Operational Checkout

Equipment pre-operational checks and tests shall include, but are not limited to, the following:

1. Check for proper installation, alignment, support, and anchorage per the applicable manufacturers operation and maintenance manual and in accordance with the contract documents.
2. Check the equipment for proper adjustment, packing of seals, lubrication, drive connection, motor connection, and belt/chain tension per the applicable manufacturers operation and maintenance manual and in accordance with the contract documents.
3. Check the associated process, seal water, drain, and vent pipe connections for proper routing and connection. Check to insure the pipe testing was performed and signed as completed for all the associated piping.
4. Insure that the equipment is clean and free of any construction debris that could potentially cause a malfunction.
5. Insure that all safety guards, signage, and other safety measures such as hearing protection, etc., are in place.
6. Have the manufacturer’s representative perform all pre-operational tests per the manufacturers' recommendations and review the equipment installation and sign the Manufacturer’s Installation

portion of the certification form. If the manufacturer's representative brings his own checklist, obtain a copy of the completed form and attach it to the Contractors completed forms. Note that the manufacturer must also fill out the contract approved checkout form (their own form will not serve as a substitute).

7. All gates and valves associated with the equipment system must be checked for proper installation, adjustment, and lubrication per the manufacturer's recommendations.

E. Concrete Tanks – Pre-Operational Checkout

All water-retaining concrete structures shall be tested for watertightness in accordance with ACI 350.1R. The maximum allowable leakage rate shall be 0.075% over a 24-hour period.

F. Electrical Pre-Operational Checks/Tests

Prior to energizing electrical circuits, use a 1,000-volt megohmeter to measure insulation resistance on conductors and insulated parts of electrical equipment. All measurements shall meet or exceed the appropriate ICEA, NEMA, or ANSI standard. Any insulation resistance less than 10 megohms is unacceptable. Record results, as well as ambient temperature. See attached form for example.

1. Measure phase-to-ground insulation resistance for all circuits 120 volts and above, with the exception of lighting circuits. Measurements may be made with motors and other equipment connected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.
2. Complete Test Form for each installed motor. Measure the insulation resistance of all motors before connection. Measure the insulation resistance for all motors at the time of delivery as well as when connected. Insulation resistance values less than 10 megohms are not acceptable.
3. Adjust and make operative all protective devices. Perform a functional check of the control circuit prior to energization of the equipment.
4. Review all associated electrical terminations, switches, and breakers for satisfactory installation.

G. Individual Component/Instrument Calibration Pre-Operational Check/Test

1. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test report form. Alarm trips, control trips, and switches shall be set to initial values specified in

the design at this time. Final elements shall be checked for range, dead band, and speed of response.

2. Calibration of analysis instruments, sensors, gauges, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system operational, performance or acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the City's Engineer.
3. Testing of instrument process piping/tubing, wiring and individual components shall be completed and documented on the approved test forms provided to the City Engineer as part of the pre-operational testing phase and prior to commencement of individual loop testing conducted during the pre-operational functional test phase.
4. Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.
5. System instrumentation equipment supplied and installed must also be reviewed for proper installation and termination as part of the pre-operational checkout.

H. Pre-Operational Checkout Summary

1. The pre-operational checkout and testing for each item shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved pre-operational test forms.
2. The Contractor shall complete the pre-operational testing requirements listed above, at a minimum, for each item of mechanical, electrical, instrumentation, and HVAC equipment prior to beginning any functional testing with regard to the equipment or the systems in which the equipment functions.

3.4 STEP 2 - FUNCTIONAL TEST

A. General

1. The second step in the program is the Functional Test. This is the functional testing of the equipment. These tests begin for each item of equipment only after the Pre-operational Checks have been completed for all components for the particular equipment.
2. The functional testing for each item of equipment shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved functional test forms.
3. Once 1) all affected equipment has been subjected to the required pre-operational testing procedures; and 2) the City Engineer has witnessed and has not found deficiencies in that portion of the

work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the Contract Standards. If available, plant process media may be employed for the testing of all liquid systems except gaseous, oil, or chemical systems. If not available, potable water shall be employed as the test medium. Test media for these systems shall either be the intended fluid or a compatible substitute. The equipment shall be operated for a sufficient period of time to determine machine operating characteristics, including noise, temperatures and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the City. Disposal methods for test media shall be subject to review by the City Engineer. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than 1 horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for use in the CMMS.

4. Test results shall be within the tolerances set forth in the detailed specification sections of the Contract Documents and as indicated in the Contractors functional test plan and the manufacturers criteria. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the City Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of such test, then the City Engineer may order the test to be repeated at the Contractors expense. Where the results of any functional test fail to comply with the Contract Standards for such test, then such repeat tests as may be necessary to achieve the Contract Standards shall be made by the Contractor at his expense.

B. The Functional Test reports (test documentation) include the required testing. Examples of these types of reports include, but are not limited to:
   1. The Functional Field Test of valves.
   2. The cycling/functions check of the sluice gates, slide gates, weir gates, stop logs, and stop plates.
   3. The leakage testing of sluice gates, slide gates, weir gates, stop logs, and stop plates in accordance with AWWA specifications.
   4. Vibration, noise, and capacity testing of Pumps.
   5. Air distribution and leakage test of any diffused air systems.

6. Loop functional test for Instrumentation and Control.

C. Process/Mechanical/Equipment – (Functional Testing)

1. During the Functional Verification Check and Testing process, the Contractor and the various Manufacturers' Technical representatives shall examine and record the initial start-up performance of the components provided by their respective firms in accordance with the Contractors approved functional test procedure.
2. The initial operation, testing and adjustment shall be as required to prove that the equipment has been installed properly and operates under the conditions specified.
3. Upon completion of this work, the manufacturer's field service technician shall complete the Contractors approved functional test form as well as their own signed report to record the results of his/her inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.

D. Electrical - (Functional Testing)

1. The Contractors' electrician shall be present during all testing to confirm the electrical, provide troubleshooting assistance, repair as needed, and assist in gathering baseline data such as motor amperages.
2. Energize each control circuit and operate each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. The Contractor shall submit a description of his proposed functional electrical test procedures as part of the testing plan.
3. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

E. Instrumentation and Control – (Functional Testing)

1. The Contractors' instrumentation representative shall be on site full time during the functional test phase to perform loop checks and to support the Contractors start-up team as needed. Any packaged equipment or manufacturer supplied control panels must be field tested to verify all control interlocks and control functions during this phase of testing by the equipment supplier. Note that the Contractors functional test procedure for each piece of equipment shall define each interlock to be tested.
2. Each instrument loop shall be tested. This testing shall check operation from transmitter to readout components. Signals shall be

generated utilizing the primary measuring elements where possible. Signals shall be injected only if primary element is unavailable.

3. If any output device fails to indicate properly, corrections to the loop shall be made as necessary and the test repeated until all instruments operate properly.

F. Functional Testing Summary

The functional testing for each item of equipment, electrical, and instrumentation shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved functional test forms.

3.5 STEP 3 – OPERATIONAL TESTING

A. The third step in the program is the Operational Testing. This step begins after all Pre-operational checks and Functional tests have been satisfactorily completed. The Contractor shall plan his activities to allow for City witnessing of all tests and shall provide twenty-four (24) hours advance notice of all testing activities.

B. The Contractors operational test plan shall be a detailed procedure to confirm all System Automatic Mode functions, verify all system interlocks, and reconfirm all equipment functions and controls. All design and performance criteria will be demonstrated and documented during this 5-day period. The Contractors manufacturer, electrical, and instrumentation representatives will be on site on an 8 hour a day basis and locally on a 24-hours a day basis during this period.

C. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.

3.6 STEP 4 – ACCEPTANCE TESTING

A. The fourth step in the program is Acceptance Testing. The acceptance test period shall not begin until all new systems and equipment have successfully completed the operational test period.

B. The Operations and Maintenance staff shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and

maintenance instruction prior to the startup with plant process media. All valve tagging shall also be complete prior to this startup.

C. As part of the acceptance test plan the Contractor shall submit detailed work plans, communications plan, safety plan, contingencies, and other requirements as outlined under tie-ins and modifications to existing systems (SC-24). Also, a 30-day test overview and proposed spreadsheet forms to be utilized by the Contractors operations staff to record appropriate operational and performance data on a regular interval for the 30 days.

D. Prerequisites

1. Prior to the City's issuance of a Certificate of Substantial Completion for all Improvements, the contractor shall perform Acceptance Testing. Acceptance Testing and the Acceptance Test Plan shall comprehensively cover all potential modes of operation, including failure scenarios, as well as the operation of ancillary systems, to demonstrate full functionality of the Improved Facilities. Any failures of process, equipment or systems shall result in re-starting the acceptance testing period. The testing period shall be a minimum of 30 days of continuous operation, during which the facility must meet the following criteria:
2. Continuous satisfactory operation at the rated capacity;
3. Operation without violating the Contract Standards;
4. Operation without creating a materially unsafe condition, nuisance condition or unacceptable risk to personnel, facilities or the public;
5. Operation without producing Biosolids products, air or water emissions, traffic, noise, odors, or other environmental impacts that the City, in its sole discretion, determines to be unacceptable to public safety, health or welfare.
6. All portions of the acceptance test phase will be carried out by qualified/certified operations personnel (supplied by the Contractor) that have a thorough knowledge of the process and can fully implement and document the facility performance as well as the Contractors acceptance test plan.

E. Instrumentation Acceptance Test

1. The instrument loop acceptance test shall fully demonstrate stable operation of the loop under normal operating conditions. This test shall be witnessed by a City Engineer and performed and documented by the Instrumentation System Supplier.
2. Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4 amplitude damping unless otherwise specified and witnessed during system supplier factory testing.

F. Flow Meters

Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than 2 inches shall be calibrated in-situ using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated in-situ using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range and witnessed by a City Engineer. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

G. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.

H. All completed operational test forms will be placed into the master record test plan binder and provided to the City of Atlanta prior to acceptance.

END OF SECTION 01650

SECTION 01664

TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

This section contains requirements for training the City's personnel, by persons retained by the CONTRACTOR specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this Contract.

1.2 QUALITY ASSURANCE

Where required by the detailed specifications, the CONTRACTOR shall provide on-the-job training of the City's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.3 SUBMITTALS

The following information shall be submitted to the City's Engineer in accordance with paragraph GC-31 of the GENERAL CONDITIONS. The material shall be reviewed and accepted by the City's Engineer as a condition precedent to receiving progress payments in excess of 75 percent of the Contract amount and not less than 3 weeks prior to the commencement of training.

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

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

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

D. 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.

E. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

2.1 GENERAL

Where specified, the CONTRACTOR shall conduct training sessions for the City's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work after the equipment has been installed and tested and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least 30 days prior to the date scheduled for the individual training session.

2.2 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.

2.3 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 Special Conditions and Section 01650, FACILITY STARTUP.

2.4 LOCATION

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

2.5 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 City and shall be suitably bound for proper organization and easy reproduction. The CONTRACTOR shall furnish ten copies of necessary training manuals, handouts, visual aids and reference materials at least 1 week prior to each training session.

2.6 FORMAT AND CONTENT

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:

A. Familiarization:
   1. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
   2. Check out the installation of the specific equipment items.
   3. Demonstrate the installed unit and indicate how all parts of the specifications are met.
   4. Answer questions.

B. Safety:
   1. Using material previously provided and installed equipment, review safety references.
   2. Discuss proper precautions around equipment.

C. Operation:
   1. Using material previously provided and installed equipment, review reference literature.
   2. Explain all modes of operation (including emergency).
   3. Check out City's personnel on proper use of the equipment.

D. Preventive Maintenance:
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.
3. Show how to perform PM jobs.
4. Show City's personnel what to look for as indicators of equipment problems.

E. Corrective Maintenance:
1. List possible problems.
2. Discuss repairs; point out special problems.
3. Open up installed equipment and demonstrate procedures, where practical.

F. Parts:
1. Show how to use previously provided parts list and order parts.
2. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

G. Local Representatives:
1. Where to Order Parts: Name, address, and telephone.
2. Service Problems:
   a. Who to call.
   b. How to get emergency help.

H. Operation and Maintenance Manuals:
1. Review any other material submitted.
2. Update material, as required.

2.7 VIDEO RECORDING

The City will retain the services of a commercial videotaping service to record each training session. After taping, the material may be edited and supplemented by the City with professionally produced graphics to provide a permanent record. The CONTRACTOR shall advise all manufacturers providing training sessions that the material will be videotaped and shall make available to the City's videotaping CONTRACTOR such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 - EXECUTION

3.1 GENERAL

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/Manufacturer is to plan for up to three classes in any 24 hour period to ensure all shifts are properly trained

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the City prior to the start of any training. Videotaping 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.

A. As a minimum classroom equipment training for operations personnel will include:

1. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
2. Purpose and plant function of the equipment.
3. A working knowledge of the operating theory of the equipment.
4. Startup, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
5. Identify and discuss safety items and procedures.
6. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
7. Operator detection, without test instruments, of specific equipment trouble symptoms.
8. Required equipment exercise procedures and intervals.
9. Routine disassembly and assembly of equipment if applicable (as judged by the City on a case-by-case basis) for purposes such as operator inspection of equipment.

B. As a minimum, hands-on equipment training for operations personnel will include:

1. Identify location of equipment and review the purpose.
2. Identifying piping and flow options.
3. Identifying valves and their purpose.
4. Identifying instrumentation:

a. Location of primary element.
b. Location of instrument readout.
c. Discuss purpose, basic operation, and information interpretation.

5. Discuss, demonstrate, and perform standard operating procedures and routine checks.
6. Discuss and perform the preventative maintenance activities.
7. Discuss and perform startup and shutdown procedures.
8. Perform the required equipment exercise procedures.
9. Perform routine disassembly and assembly of equipment if applicable.
10. Identify and review safety items and perform safety procedures, if feasible.

C. Classroom equipment training for the maintenance and repair personnel will include:

1. Theory of operation.
2. Description and function of equipment.
3. Startup and shutdown procedures.
4. Normal and major repair procedures.
5. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
6. Routine and long-term calibration procedures.
7. Safety procedures.
8. 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.

D. Hands-on equipment training for maintenance and repair personnel shall include:

1. Locate and identify equipment components.
2. Review the equipment function and theory of operation.
3. Review normal repair procedures.
4. Perform startup and shutdown procedures.
5. Review and perform the safety procedures.
6. Perform City approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01780

ASSET MANAGEMENT RECORDS

PART 1 - GENERAL

1.1 SCOPE

The work under this Section includes gathering and electronically recording financial and technical information needed to support the Owner's Fixed Asset Registry and Computerized Maintenance Management System (CMMS).

1.2 FIXED ASSETS

A. The Contractor shall generate the financial information necessary to support the Owner's Fixed Asset Registry, CMMS and submit the information periodically, as directed by the Engineer.

B. Financial information (Purchase/Salvage/Disposal Price) shall be provided for the following categories of assets:

1. Equipment - All equipment with a purchase value of $5,000 or more and all equipment that has been assigned an "equipment" or "tag" number in contract documents. The term "equipment" includes but is not limited to: all process equipment, HVAC equipment, instrumentation, valves and gates (including actuators), tanks, electrical panels (including switchgear, MCCs, VFDs, panel boards, automatic transfer switches, heat trace panels, and the like), factory and field control panels, patch panels, control system panels (including PLC and DCS cabinets, marshalling (I/O) cabinets, etc.), roll-up doors, cranes and hoists, copiers, maintenance equipment, shelving, cabinets, laboratory equipment, furniture and A/V equipment. The asset value of the equipment shall be the Contractor's actual purchase price without installation, taxes, overheads, or mark-ups. The Contractor shall obtain a breakdown of equipment values from its vendors and suppliers, where possible, and use its best efforts to provide or estimate the actual purchase price. In addition, the Contractor shall provide an estimate of the cost of installation of each equipment item (e.g., setting, aligning, grouting, etc.)
2. Structure – The cost of structures (typically those structures that require individual building permits) including all labor associated with the structure and all materials (including piping, raceway, wiring, supports, and appurtenances) incorporated into the structure. The structure cost shall include all improvements to the structure and, as applicable, the cost of demolition or other changes to the structure, as directed by the Engineer.

3. Site Improvements – The cost of site improvements shall include all earthwork, manholes / handholes, culverts and drainage structures, piping, ductbank and wiring not incorporated in a structure, roads, curbs, sidewalks, grassing and landscaping, demolition, and any other improvements to the site. The site improvements cost shall include all improvements to the site and, as applicable, the cost of demolition or other changes to the site, as directed by the Engineer.
4. Special Items – Certain portions of the construction may have a different useful life (from an accounting standpoint). An example of this is roofing on a structure. These special items, as directed by the Engineer, shall be listed separately. The Contractor shall also provide an estimate of the installation cost of the special item.
5. General Costs - The Contractor shall provide, as a separate line item when directed by the Engineer, the contractor's general costs (general conditions, field engineering, management, supervision, overhead, profit, mobilization, demobilization, permits, bonds, insurance, etc.), associated with the Project.
6. Salvage Items - The Contractor shall provide, as a separate line item when directed by the Engineer, description of items removed from service and returned to the City as Salvage associated with the Project.
7. Disposed Items - The Contractor shall provide, as a separate line item when directed by the Engineer, description of items removed from service and disposed associated with the Project.

C. The Contractor shall provide the required financial information in a format acceptable to the Engineer, with the cost information displayed individually, distributed, or rolled up as directed by the Engineer. See Part 1.06 for examples.

D. Information to be included as part of fixed asset reporting shall include, as applicable:
1. Tag Number (equipment number, structure number, other unique identification number, as applicable, and as directed by the Engineer)
2. Structure Name (for site improvements use "Site Improvements")
3. Description (equipment description or description of asset)
4. Manufacturer
5. Vendor (or supplier)
6. Model Number
7. Serial Number
8. Purchase Price (cost as defined above, if applicable)
9. Installed Date (usually the date of Substantial Completion) or Date removed from service
10. Extended Warranty Information (if applicable)

1.3 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM:

A. In addition to the Fixed Asset information described above, the Contractor shall collect information needed to support data input for the Owner's Computerized Maintenance Management System (CMMS) and submit the information periodically, as directed by the Engineer. Both the Fixed Asset and CMMS data information will be submitted monthly as a requirement of the payment application process.

B. The Contractor will collect equipment information on all installed equipment that has an associated preventative maintenance in the vendor's O&M manuals.

C. The Contractor shall take digital photos of all equipment nameplates and electronically file the information by Structure Name and Tag Number. Data (such as serial numbers) must be collected or verified from equipment after it is in its installed location.

D. A substantial part of the data needed for the CMMS is provided on the equipment nameplates, however, the Contractor may need to refer to submittals, operations and maintenance manuals, and/or other manufacturer information to obtain dimensions, weights, etc., that are not included on nameplates.

E. Part 1.05 below provides examples of information needed for various types of equipment. Multiple forms may be needed for a single piece of equipment. Actual information required will be as directed by the Engineer.

1.4 INFORMATION SUBMITTALS

A. The Contractor shall record in a Microsoft Excel spreadsheet file, the data collected for the Asset Registry and CMMS to the Owner through the Engineer.

B. The format of a typical Asset – CMMS Spreadsheet is as shown in the first two exhibits under Part 1.06 with each asset on a separate row and the various data fields in columns (only the first nine columns of a 100+ column spreadsheet are shown). Due to the nature of instrumentation, a separate detailed Instrumentation Spreadsheet (which allows multiple model / serial numbers and other unique information to be associated with a single instrument) is also shown in the third exhibit under Part 1.06. The total cost for instrumentation from the Instrumentation Spreadsheet, in the example, is entered as a line item in the Asset – CMMS Spreadsheet.

C. A separate Asset – CMMS Spreadsheet shall be prepared for each structure or portion of the Project, including site improvements, as directed by the Engineer.

D. A database with a single table and forms similar to those shown in Part 1.05 is a suggested means for data entry, with such database table exported to an MS Excel spreadsheet to produce the required spreadsheet for each structure or portion of the Project. The creation of the database is not required.

E. To the extent available, the Contractor should obtain a list(s) of equipment as described in Part 1.02 Paragraph B.1 above from the Engineer for importation into the database or spreadsheet(s).

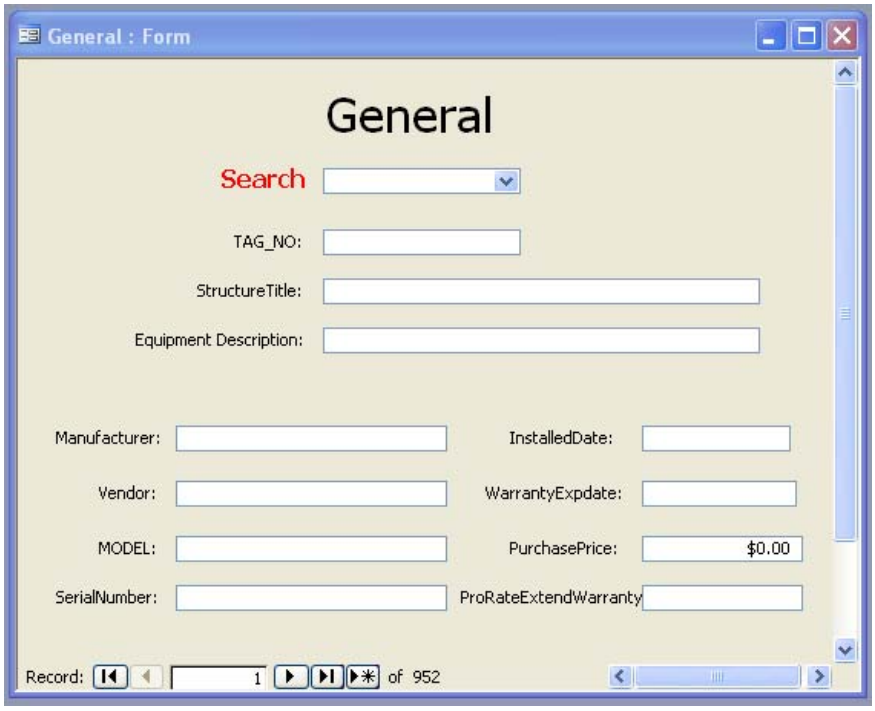
F. The Contractor shall submit to the Engineer, a draft of the Asset – CMMS Spreadsheet for each structure or portion of the Project, by the 50% construction complete stage of the structure or portion of the Project, for review as to form and completeness of the asset list. If requested by the Engineer, the Contractor shall submit copies of the spreadsheet periodically (but no more than once a month), as a work in progress for the Engineer's review. Failure to submit the spreadsheets, as requested by the Engineer, may result in delayed processing of the most current pay request (until the spreadsheet is submitted and accepted).

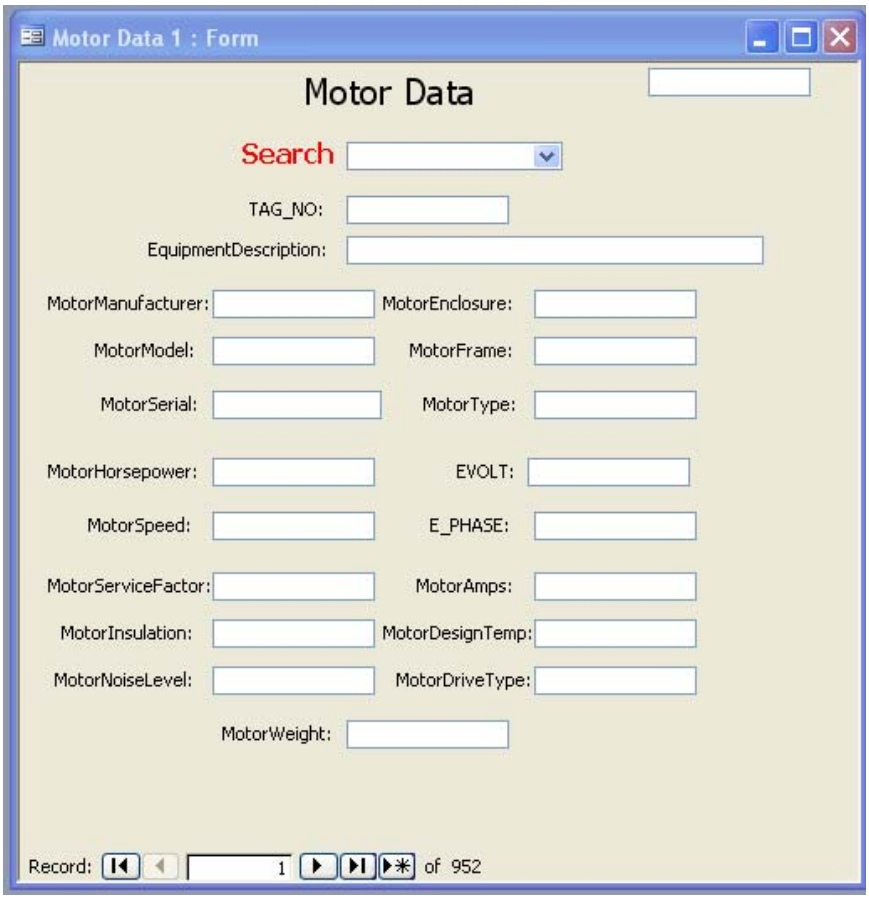
G. After an O&M has been accepted with no exceptions taken, the preventative maintenance detailed in the O&M manual shall be entered in an Excel spreadsheet for importation into the City's CMMS. The Contractor will submit copies of the spreadsheet as part of the CMMS Spreadsheet submittal as a work in progress for the Engineer's review. Failure to submit the spreadsheets, as requested by the Engineer, may result in delayed processing of the most current pay request (until the spreadsheet is submitted and accepted).

H. The Contractor shall submit, to the Engineer, a preliminary copy of the Asset - CMMS Spreadsheet for any structure or portion of the Project a minimum of sixty (60) days prior to the anticipated Substantial Completion date for that structure or portion of the Project, with all information complete, except for the date of Substantial Completion. The final Asset - CMMS Spreadsheet for each structure or portion of the Project shall be submitted as part of the requirement for Substantial Completion. Failure to submit the spreadsheet as described above may result in delay in achieving Substantial Completion.

I. At the end of the Project, all Asset -CMMS Spreadsheets pertaining to the work must be complete, submitted to and accepted by the Engineer in order to achieve Final Completion of the Project. The total of all spreadsheets for the Project must equal the total Contract Price.

1.5 EXAMPLES OF TYPICAL DATA AND SUGGESTED DATABASE TABLES

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Motor Data
Search
TAG_NO:
EquipmentDescription:
MotorManufacturer:
MotorEnclosure:
MotorModel:
MotorFrame:
MotorSerial:
MotorType:
MotorHorsepower:
EVOLT:
MotorSpeed:
E_PHASE:
MotorServiceFactor:
MotorAmps:
MotorInsulation:
MotorDesignTemp:
MotorNoiseLevel:
MotorDriveType:
MotorWeight:
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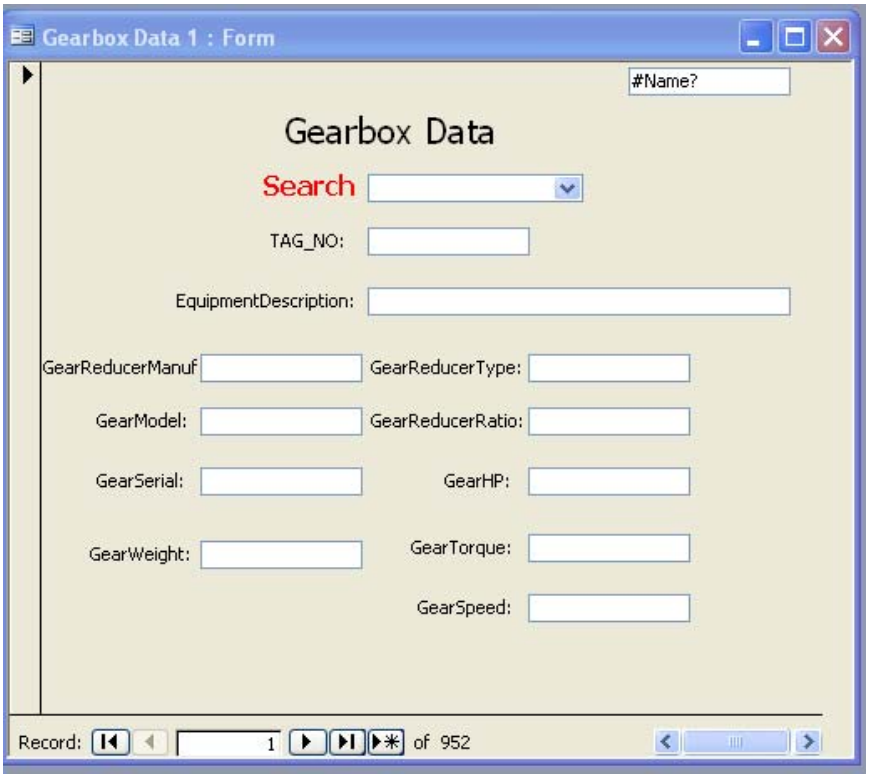
1
of 952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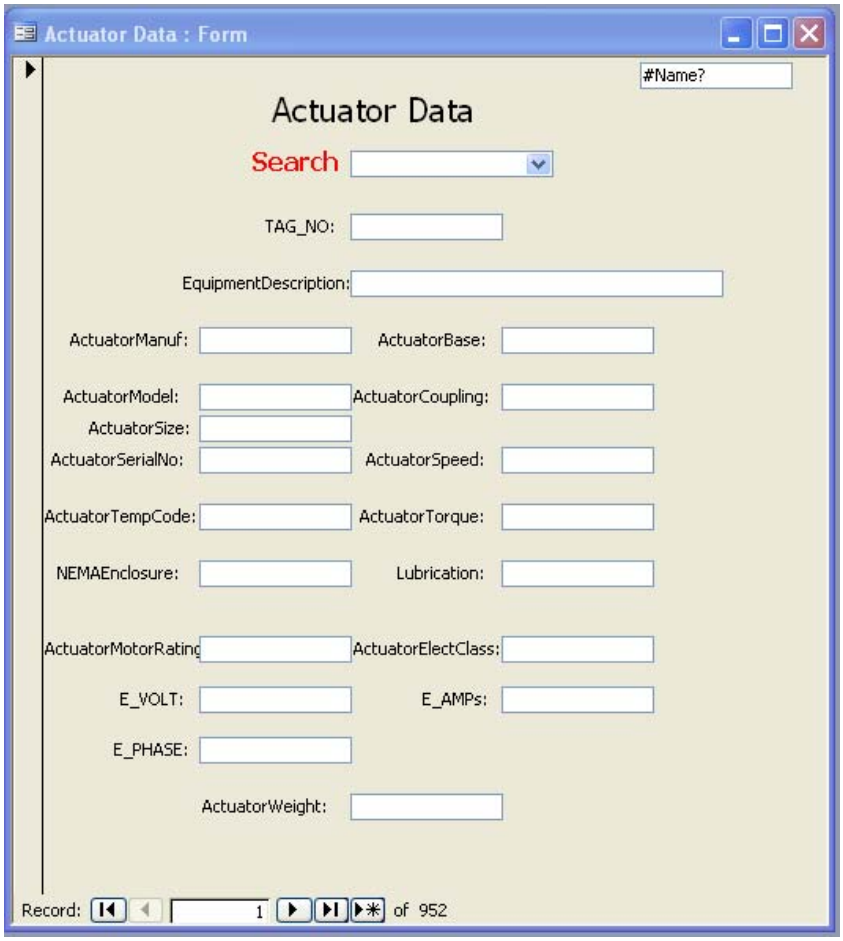
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ActuatorSpeed:
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ActuatorTorque:
NEMAEnclosure:
Lubrication:
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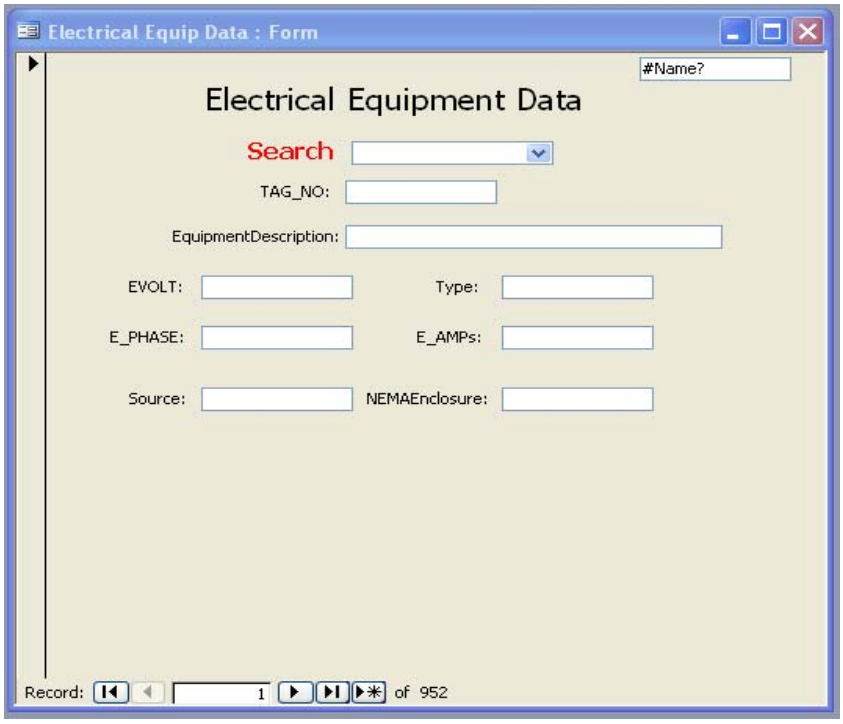
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Source:
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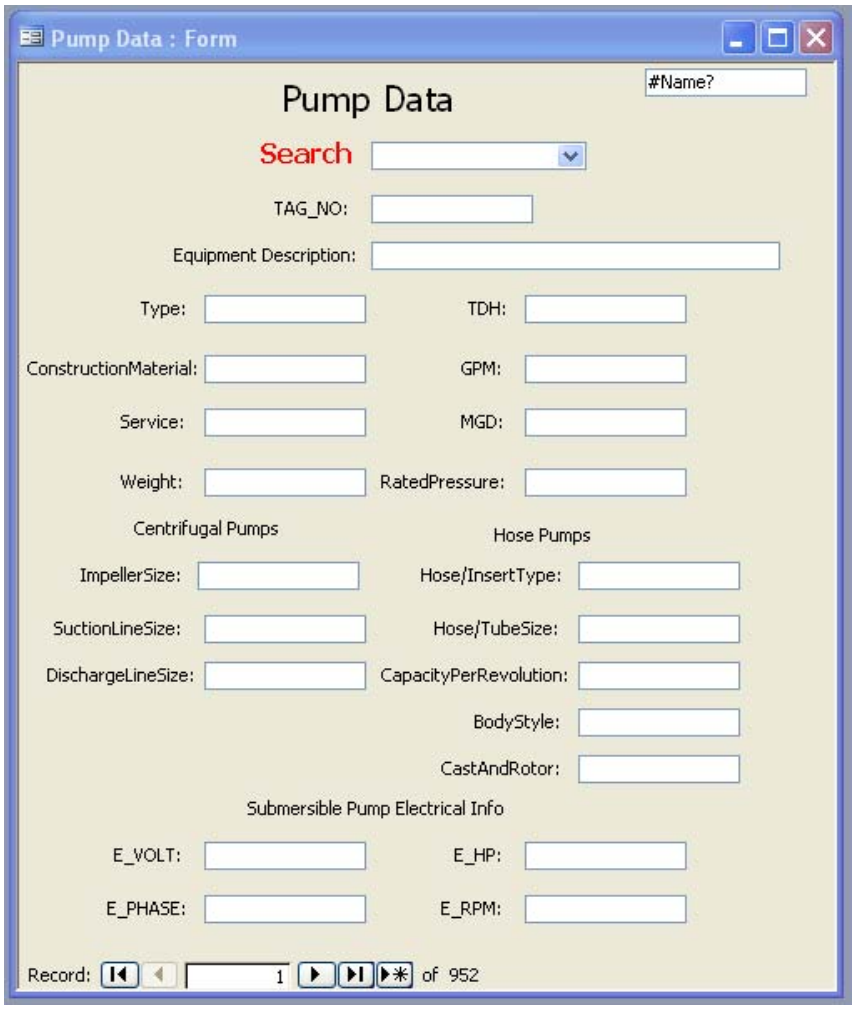
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GPM:
Service:
MGD:
Weight:
RatedPressure:
Centrifugal Pumps
Hose Pumps
ImpellerSize:
Hose/InsertType:
SuctionLineSize:
Hose/TubeSize:
DischargeLineSize:
CapacityPerRevolution:
BodyStyle:
CastAndRotor:
Submersible Pump Electrical Info
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E_HP:
E_PHASE:
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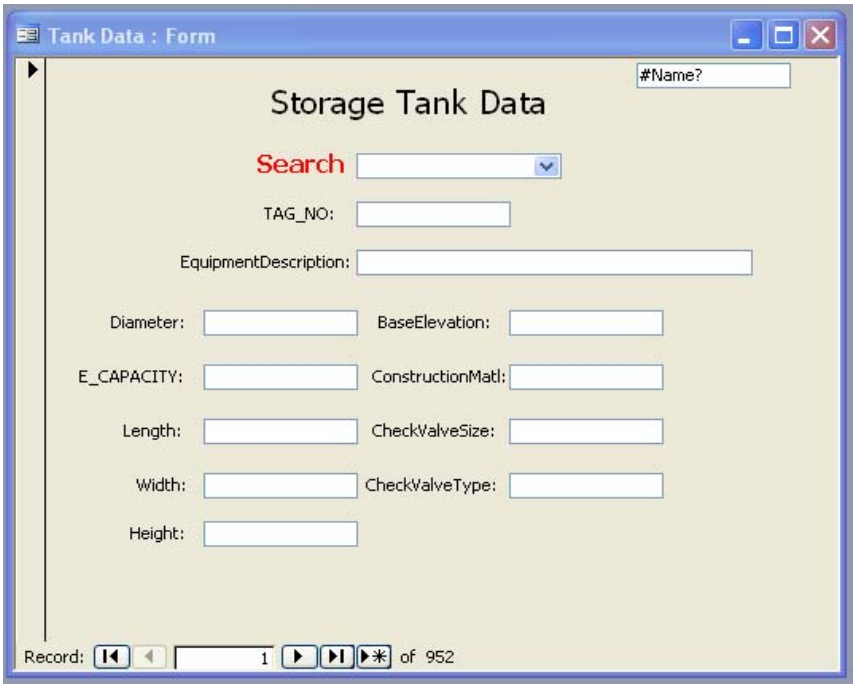
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CheckValveType:
Height:
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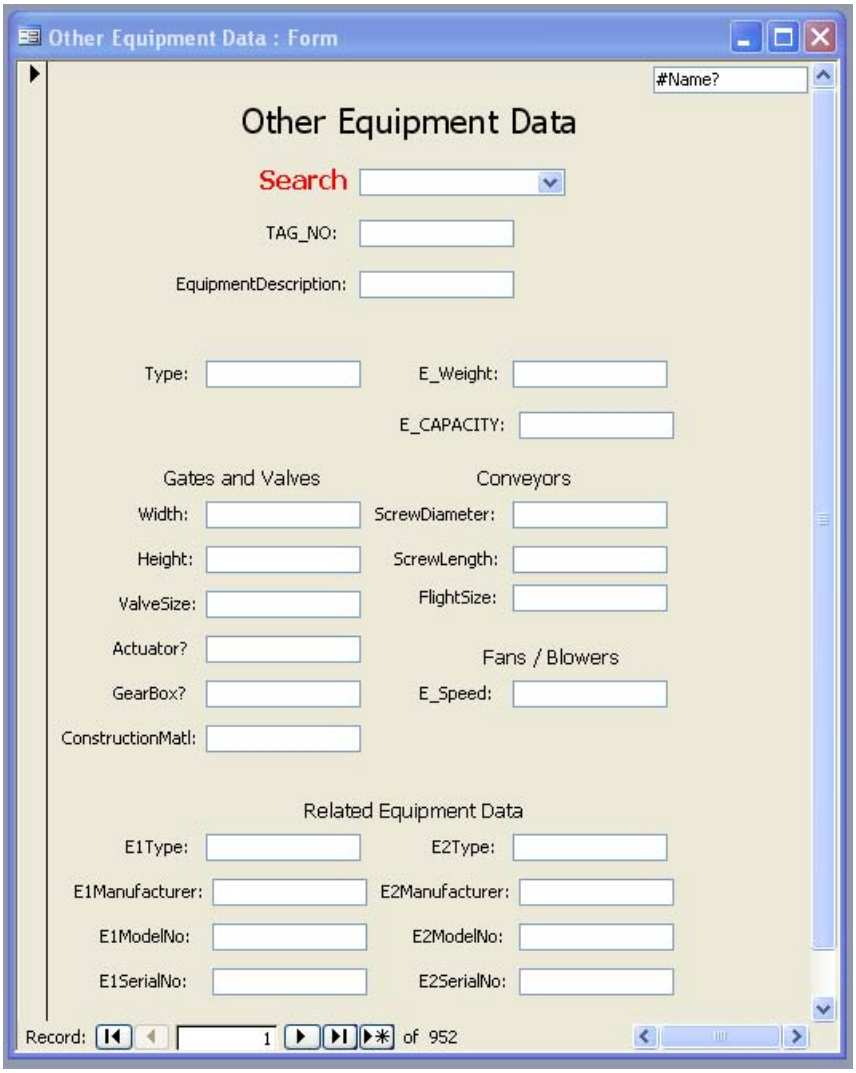
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Other Equipment Data
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E_CAPACITY:
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Height:
ValveSize:
Actuator?
GearBox?
ConstructionMatl:
Conveyors
ScrewDiameter:
ScrewLength:
FlightSize:
Fans / Blowers
E_Speed:
Related Equipment Data
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E2Type:
E1Manufacturer:
E2Manufacturer:
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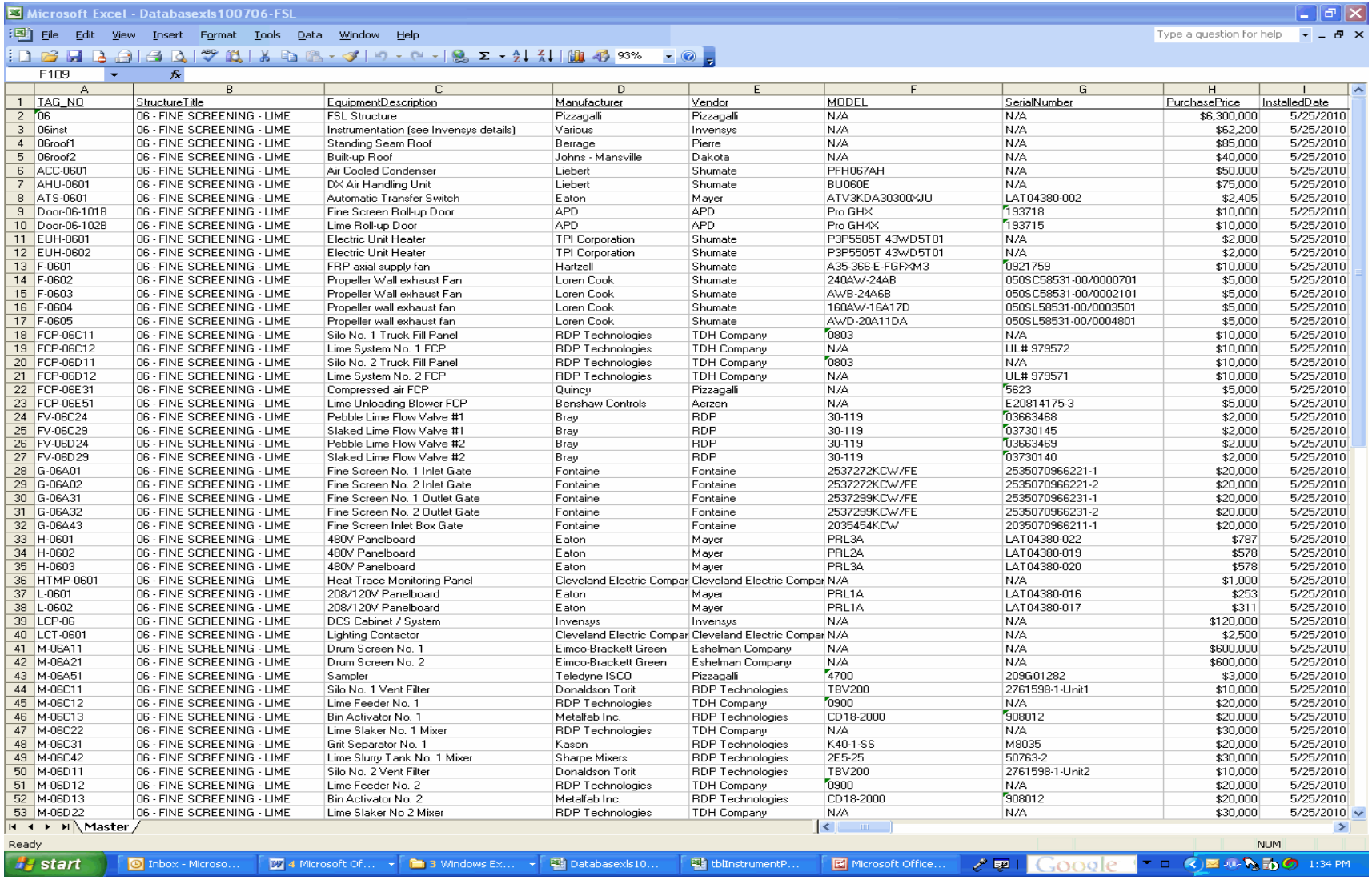
1.6 ASSET REGISTRY CMMS SPREADSHEET EXAMPLES



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	A	B	C	D	E	F	G	H	I
1	TAG_NO	StructureTitle	EquipmentDescription	Manufacturer	Vendor	MODEL	SerialNumber	PurchasePrice	InstalledDate
2	06	06 - FINE SCREENING - LIME	FSL Structure	Pizzagalli	Pizzagalli	N/A	N/A	$6,300,000	5/25/2010
3	06inst	06 - FINE SCREENING - LIME	Instrumentation (see Invensys details)	Various	Invensys	N/A	N/A	$62,200	5/25/2010
4	06roof1	06 - FINE SCREENING - LIME	Standing Seam Roof	Berrage	Pierre	N/A	N/A	$85,000	5/25/2010
5	06roof2	06 - FINE SCREENING - LIME	Built-up Roof	Johns - Mansville	Dakota	N/A	N/A	$40,000	5/25/2010
6	ACC-0601	06 - FINE SCREENING - LIME	Air Cooled Condenser	Liebert	Shumate	PFH067AH	N/A	$50,000	5/25/2010
7	AHU-0601	06 - FINE SCREENING - LIME	DX Air Handling Unit	Liebert	Shumate	BU060E	N/A	$75,000	5/25/2010
8	ATS-0601	06 - FINE SCREENING - LIME	Automatic Transfer Switch	Eaton	Mayer	ATV3KDA30300KJU	LAT04380-002	$2,405	5/25/2010
9	Door-06-101B	06 - FINE SCREENING - LIME	Fine Screen Roll-up Door	APD	APD	Pro GHX	193718	$10,000	5/25/2010
10	Door-06-102B	06 - FINE SCREENING - LIME	Lime Roll-up Door	APD	APD	Pro GH4X	193715	$10,000	5/25/2010
11	EUH-0601	06 - FINE SCREENING - LIME	Electric Unit Heater	TPI Corporation	Shumate	P3P5505T 43WD5T01	N/A	$2,000	5/25/2010
12	EUH-0602	06 - FINE SCREENING - LIME	Electric Unit Heater	TPI Corporation	Shumate	P3P5505T 43WD5T01	N/A	$2,000	5/25/2010
13	F-0601	06 - FINE SCREENING - LIME	FRP axial supply fan	Hartzell	Shumate	A35-366-E-FGFXM3	0921759	$10,000	5/25/2010
14	F-0602	06 - FINE SCREENING - LIME	Propeller Wall exhaust Fan	Loren Cook	Shumate	240AW-24AB	050SC58531-00/0000701	$5,000	5/25/2010
15	F-0603	06 - FINE SCREENING - LIME	Propeller Wall exhaust Fan	Loren Cook	Shumate	AWB-24A6B	050SC58531-00/0002101	$5,000	5/25/2010
16	F-0604	06 - FINE SCREENING - LIME	Propeller wall exhaust fan	Loren Cook	Shumate	160AW-16A17D	050SL58531-00/0003501	$5,000	5/25/2010
17	F-0605	06 - FINE SCREENING - LIME	Propeller wall exhaust fan	Loren Cook	Shumate	AWD-20A11DA	050SL58531-00/0004801	$5,000	5/25/2010
18	FCP-06C11	06 - FINE SCREENING - LIME	Silo No. 1 Truck Fill Panel	RDP Technologies	TDH Company	0803	N/A	$10,000	5/25/2010
19	FCP-06C12	06 - FINE SCREENING - LIME	Lime System No. 1 FCP	RDP Technologies	TDH Company	N/A	UL# 979572	$10,000	5/25/2010
20	FCP-06D11	06 - FINE SCREENING - LIME	Silo No. 2 Truck Fill Panel	RDP Technologies	TDH Company	0803	N/A	$10,000	5/25/2010
21	FCP-06D12	06 - FINE SCREENING - LIME	Lime System No. 2 FCP	RDP Technologies	TDH Company	N/A	UL# 979571	$10,000	5/25/2010
22	FCP-06E31	06 - FINE SCREENING - LIME	Compressed air FCP	Quincy	Pizzagalli	N/A	5623	$5,000	5/25/2010
23	FCP-06E51	06 - FINE SCREENING - LIME	Lime Unloading Blower FCP	Benshaw Controls	Aerzen	N/A	E20814175-3	$5,000	5/25/2010
24	FV-06C24	06 - FINE SCREENING - LIME	Pebble Lime Flow Valve #1	Bray	RDP	30-119	03663468	$2,000	5/25/2010
25	FV-06C29	06 - FINE SCREENING - LIME	Slaked Lime Flow Valve #1	Bray	RDP	30-119	03730145	$2,000	5/25/2010
26	FV-06D24	06 - FINE SCREENING - LIME	Pebble Lime Flow Valve #2	Bray	RDP	30-119	03663469	$2,000	5/25/2010
27	FV-06D29	06 - FINE SCREENING - LIME	Slaked Lime Flow Valve #2	Bray	RDP	30-119	03730140	$2,000	5/25/2010
28	G-06A01	06 - FINE SCREENING - LIME	Fine Screen No. 1 Inlet Gate	Fontaine	Fontaine	2537272KCW/FE	2535070966221-1	$20,000	5/25/2010
29	G-06A02	06 - FINE SCREENING - LIME	Fine Screen No. 2 Inlet Gate	Fontaine	Fontaine	2537272KCW/FE	2535070966221-2	$20,000	5/25/2010
30	G-06A31	06 - FINE SCREENING - LIME	Fine Screen No. 1 Outlet Gate	Fontaine	Fontaine	2537299KCW/FE	2535070966231-1	$20,000	5/25/2010
31	G-06A32	06 - FINE SCREENING - LIME	Fine Screen No. 2 Outlet Gate	Fontaine	Fontaine	2537299KCW/FE	2535070966231-2	$20,000	5/25/2010
32	G-06A43	06 - FINE SCREENING - LIME	Fine Screen Inlet Box Gate	Fontaine	Fontaine	2035454KCW	2035070966211-1	$20,000	5/25/2010
33	H-0601	06 - FINE SCREENING - LIME	480V Panelboard	Eaton	Mayer	PRL3A	LAT04380-022	$787	5/25/2010
34	H-0602	06 - FINE SCREENING - LIME	480V Panelboard	Eaton	Mayer	PRL2A	LAT04380-019	$578	5/25/2010
35	H-0603	06 - FINE SCREENING - LIME	480V Panelboard	Eaton	Mayer	PRL3A	LAT04380-020	$578	5/25/2010
36	HTMP-0601	06 - FINE SCREENING - LIME	Heat Trace Monitoring Panel	Cleveland Electric Compar	Cleveland Electric Compar	N/A	N/A	$1,000	5/25/2010
37	L-0601	06 - FINE SCREENING - LIME	208/120V Panelboard	Eaton	Mayer	PRL1A	LAT04380-016	$253	5/25/2010
38	L-0602	06 - FINE SCREENING - LIME	208/120V Panelboard	Eaton	Mayer	PRL1A	LAT04380-017	$311	5/25/2010
39	LCP-06	06 - FINE SCREENING - LIME	DCS Cabinet / System	Invensys	Invensys	N/A	N/A	$120,000	5/25/2010
40	LCT-0601	06 - FINE SCREENING - LIME	Lighting Contactor	Cleveland Electric Compar	Cleveland Electric Compar	N/A	N/A	$2,500	5/25/2010
41	M-06A11	06 - FINE SCREENING - LIME	Drum Screen No. 1	Eimco-Brackett Green	Eshelman Company	N/A	N/A	$600,000	5/25/2010
42	M-06A21	06 - FINE SCREENING - LIME	Drum Screen No. 2	Eimco-Brackett Green	Eshelman Company	N/A	N/A	$600,000	5/25/2010
43	M-06A51	06 - FINE SCREENING - LIME	Sampler	Teledyne ISCO	Pizzagalli	4700	209G01282	$3,000	5/25/2010
44	M-06C11	06 - FINE SCREENING - LIME	Silo No. 1 Vent Filter	Donaldson Torit	RDP Technologies	TBV200	2761598-1-Unit1	$10,000	5/25/2010
45	M-06C12	06 - FINE SCREENING - LIME	Lime Feeder No. 1	RDP Technologies	TDH Company	0900	N/A	$20,000	5/25/2010
46	M-06C13	06 - FINE SCREENING - LIME	Bin Activator No. 1	Metalfab Inc.	RDP Technologies	CD18-2000	908012	$20,000	5/25/2010
47	M-06C22	06 - FINE SCREENING - LIME	Lime Slaker No. 1 Mixer	RDP Technologies	TDH Company	N/A	N/A	$30,000	5/25/2010
48	M-06C31	06 - FINE SCREENING - LIME	Grit Separator No. 1	Kason	RDP Technologies	K40-1-SS	M8035	$20,000	5/25/2010
49	M-06C42	06 - FINE SCREENING - LIME	Lime Slurry Tank No. 1 Mixer	Sharpe Mixers	RDP Technologies	2E5-25	50763-2	$30,000	5/25/2010
50	M-06D11	06 - FINE SCREENING - LIME	Silo No. 2 Vent Filter	Donaldson Torit	RDP Technologies	TBV200	2761598-1-Unit2	$10,000	5/25/2010
51	M-06D12	06 - FINE SCREENING - LIME	Lime Feeder No. 2	RDP Technologies	TDH Company	0900	N/A	$20,000	5/25/2010
52	M-06D13	06 - FINE SCREENING - LIME	Bin Activator No. 2	Metalfab Inc.	RDP Technologies	CD18-2000	908012	$20,000	5/25/2010
53	M-06D22	06 - FINE SCREENING - LIME	Lime Slaker No 2 Mixer	RDP Technologies	TDH Company	N/A	N/A	$30,000	5/25/2010

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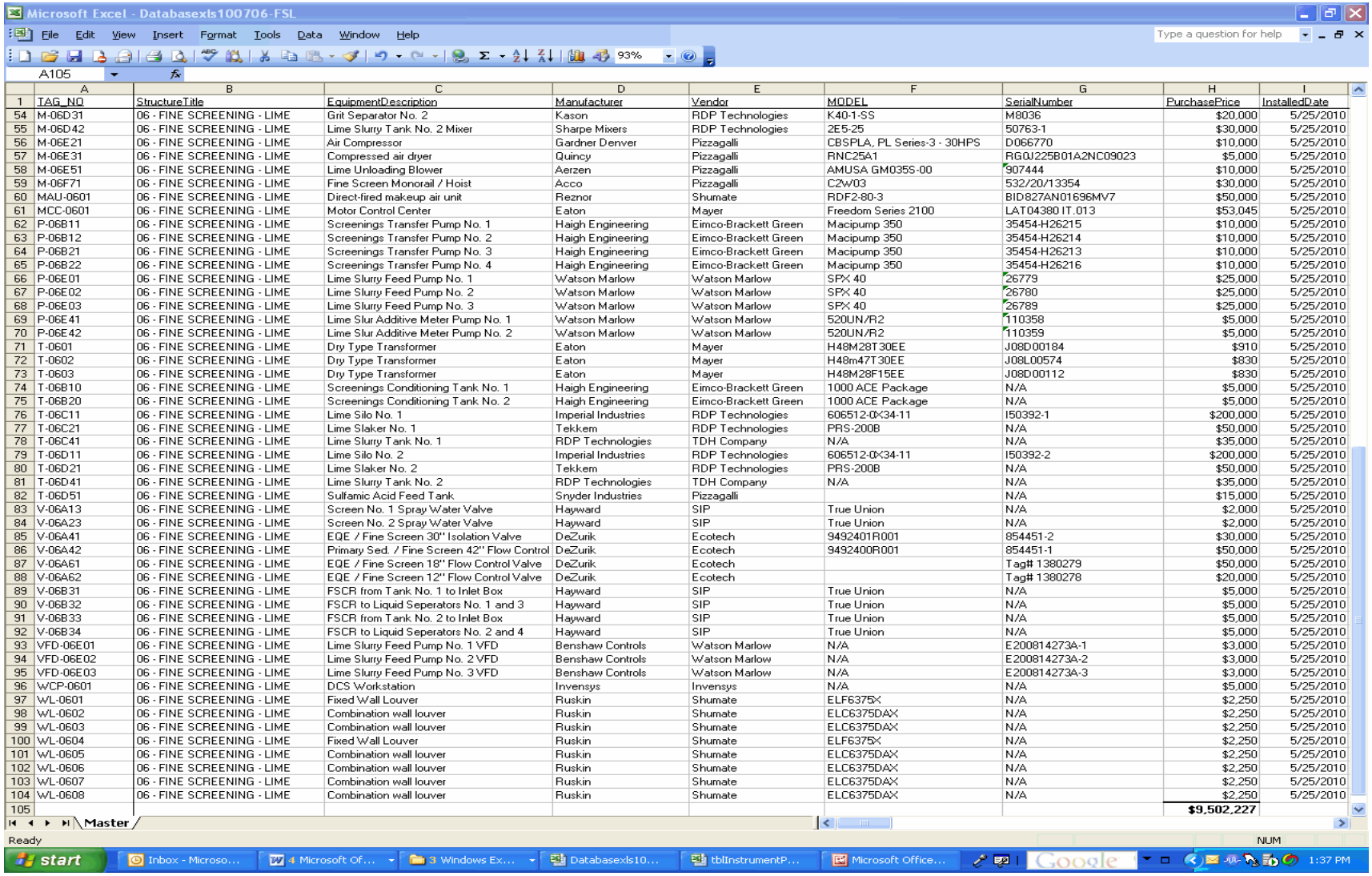

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1	TAG_NO	StructureTitle	EquipmentDescription	Manufacturer	Vendor	MODEL	SerialNumber	PurchasePrice	InstalledDate
54	M-06D31	06 - FINE SCREENING - LIME	Grit Separator No. 2	Kason	RDP Technologies	K40-1-SS	M8036	$20,000	5/25/2010
55	M-06D42	06 - FINE SCREENING - LIME	Lime Slurry Tank No. 2 Mixer	Sharpe Mixers	RDP Technologies	2E5-25	50763-1	$30,000	5/25/2010
56	M-06E21	06 - FINE SCREENING - LIME	Air Compressor	Gardner Denver	Pizzagalli	CBSPLA, PL Series-3 - 30HPS	D066770	$10,000	5/25/2010
57	M-06E31	06 - FINE SCREENING - LIME	Compressed air dryer	Quincy	Pizzagalli	RNC25A1	RGQJ225B01A2NC09023	$5,000	5/25/2010
58	M-06E51	06 - FINE SCREENING - LIME	Lime Unloading Blower	Aerzen	Pizzagalli	AMUSA GM035S-00	907444	$10,000	5/25/2010
59	M-06F71	06 - FINE SCREENING - LIME	Fine Screen Monorail / Hoist	Acco	Pizzagalli	CZW03	532/20/13354	$30,000	5/25/2010
60	MAU-0601	06 - FINE SCREENING - LIME	Direct-fired makeup air unit	Reznor	Shumate	RDF2-80-3	BID827AN01696MV7	$50,000	5/25/2010
61	MCC-0601	06 - FINE SCREENING - LIME	Motor Control Center	Eaton	Mayer	Freedom Series 2100	LAT04380 IT.013	$53,045	5/25/2010
62	P-06B11	06 - FINE SCREENING - LIME	Screenings Transfer Pump No. 1	Haigh Engineering	Eimco-Brackett Green	Macipump 350	35454-H26215	$10,000	5/25/2010
63	P-06B12	06 - FINE SCREENING - LIME	Screenings Transfer Pump No. 2	Haigh Engineering	Eimco-Brackett Green	Macipump 350	35454-H26214	$10,000	5/25/2010
64	P-06B21	06 - FINE SCREENING - LIME	Screenings Transfer Pump No. 3	Haigh Engineering	Eimco-Brackett Green	Macipump 350	35454-H26213	$10,000	5/25/2010
65	P-06B22	06 - FINE SCREENING - LIME	Screenings Transfer Pump No. 4	Haigh Engineering	Eimco-Brackett Green	Macipump 350	35454-H26216	$10,000	5/25/2010
66	P-06E01	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 1	Watson Marlow	Watson Marlow	SPX 40	26779	$25,000	5/25/2010
67	P-06E02	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 2	Watson Marlow	Watson Marlow	SPX 40	26780	$25,000	5/25/2010
68	P-06E03	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 3	Watson Marlow	Watson Marlow	SPX 40	26789	$25,000	5/25/2010
69	P-06E41	06 - FINE SCREENING - LIME	Lime Slur Additive Meter Pump No. 1	Watson Marlow	Watson Marlow	520UN/R2	110358	$5,000	5/25/2010
70	P-06E42	06 - FINE SCREENING - LIME	Lime Slur Additive Meter Pump No. 2	Watson Marlow	Watson Marlow	520UN/R2	110359	$5,000	5/25/2010
71	T-0601	06 - FINE SCREENING - LIME	Dry Type Transformer	Eaton	Mayer	H48M28T30EE	J08D00184	$910	5/25/2010
72	T-0602	06 - FINE SCREENING - LIME	Dry Type Transformer	Eaton	Mayer	H48m47T30EE	J08L00574	$830	5/25/2010
73	T-0603	06 - FINE SCREENING - LIME	Dry Type Transformer	Eaton	Mayer	H48M28F15EE	J08D00112	$830	5/25/2010
74	T-06B10	06 - FINE SCREENING - LIME	Screenings Conditioning Tank No. 1	Haigh Engineering	Eimco-Brackett Green	1000 ACE Package	N/A	$5,000	5/25/2010
75	T-06B20	06 - FINE SCREENING - LIME	Screenings Conditioning Tank No. 2	Haigh Engineering	Eimco-Brackett Green	1000 ACE Package	N/A	$5,000	5/25/2010
76	T-06C11	06 - FINE SCREENING - LIME	Lime Silo No. 1	Imperial Industries	RDP Technologies	606512-0X34-11	I50392-1	$200,000	5/25/2010
77	T-06C21	06 - FINE SCREENING - LIME	Lime Slaker No. 1	Tekkem	RDP Technologies	PRS-200B	N/A	$50,000	5/25/2010
78	T-06C41	06 - FINE SCREENING - LIME	Lime Slurry Tank No. 1	RDP Technologies	TDH Company	N/A	N/A	$35,000	5/25/2010
79	T-06D11	06 - FINE SCREENING - LIME	Lime Silo No. 2	Imperial Industries	RDP Technologies	606512-0X34-11	I50392-2	$200,000	5/25/2010
80	T-06D21	06 - FINE SCREENING - LIME	Lime Slaker No. 2	Tekkem	RDP Technologies	PRS-200B	N/A	$50,000	5/25/2010
81	T-06D41	06 - FINE SCREENING - LIME	Lime Slurry Tank No. 2	RDP Technologies	TDH Company	N/A	N/A	$35,000	5/25/2010
82	T-06D51	06 - FINE SCREENING - LIME	Sulfamic Acid Feed Tank	Snyder Industries	Pizzagalli		N/A	$15,000	5/25/2010
83	V-06A13	06 - FINE SCREENING - LIME	Screen No. 1 Spray Water Valve	Hayward	SIP	True Union	N/A	$2,000	5/25/2010
84	V-06A23	06 - FINE SCREENING - LIME	Screen No. 2 Spray Water Valve	Hayward	SIP	True Union	N/A	$2,000	5/25/2010
85	V-06A41	06 - FINE SCREENING - LIME	EQE / Fine Screen 30" Isolation Valve	DeZurik	Ecotech	9492401R001	854451-2	$30,000	5/25/2010
86	V-06A42	06 - FINE SCREENING - LIME	Primary Sed. / Fine Screen 42" Flow Control	DeZurik	Ecotech	9492400R001	854451-1	$50,000	5/25/2010
87	V-06A61	06 - FINE SCREENING - LIME	EQE / Fine Screen 18" Flow Control Valve	DeZurik	Ecotech		Tag# 1380279	$50,000	5/25/2010
88	V-06A62	06 - FINE SCREENING - LIME	EQE / Fine Screen 12" Flow Control Valve	DeZurik	Ecotech		Tag# 1380278	$20,000	5/25/2010
89	V-06B31	06 - FINE SCREENING - LIME	FSCR from Tank No. 1 to Inlet Box	Hayward	SIP	True Union	N/A	$5,000	5/25/2010
90	V-06B32	06 - FINE SCREENING - LIME	FSCR to Liquid Seperators No. 1 and 3	Hayward	SIP	True Union	N/A	$5,000	5/25/2010
91	V-06B33	06 - FINE SCREENING - LIME	FSCR from Tank No. 2 to Inlet Box	Hayward	SIP	True Union	N/A	$5,000	5/25/2010
92	V-06B34	06 - FINE SCREENING - LIME	FSCR to Liquid Seperators No. 2 and 4	Hayward	SIP	True Union	N/A	$5,000	5/25/2010
93	VFD-06E01	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 1 VFD	Benshaw Controls	Watson Marlow	N/A	E200814273A-1	$3,000	5/25/2010
94	VFD-06E02	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 2 VFD	Benshaw Controls	Watson Marlow	N/A	E200814273A-2	$3,000	5/25/2010
95	VFD-06E03	06 - FINE SCREENING - LIME	Lime Slurry Feed Pump No. 3 VFD	Benshaw Controls	Watson Marlow	N/A	E200814273A-3	$3,000	5/25/2010
96	WCP-0601	06 - FINE SCREENING - LIME	DCS Workstation	Invensys	Invensys	N/A	N/A	$5,000	5/25/2010
97	WL-0601	06 - FINE SCREENING - LIME	Fixed Wall Louver	Ruskin	Shumate	ELF6375X	N/A	$2,250	5/25/2010
98	WL-0602	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
99	WL-0603	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
100	WL-0604	06 - FINE SCREENING - LIME	Fixed Wall Louver	Ruskin	Shumate	ELF6375X	N/A	$2,250	5/25/2010
101	WL-0605	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
102	WL-0606	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
103	WL-0607	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
104	WL-0608	06 - FINE SCREENING - LIME	Combination wall louver	Ruskin	Shumate	ELC6375DAX	N/A	$2,250	5/25/2010
105								$9,502,227	

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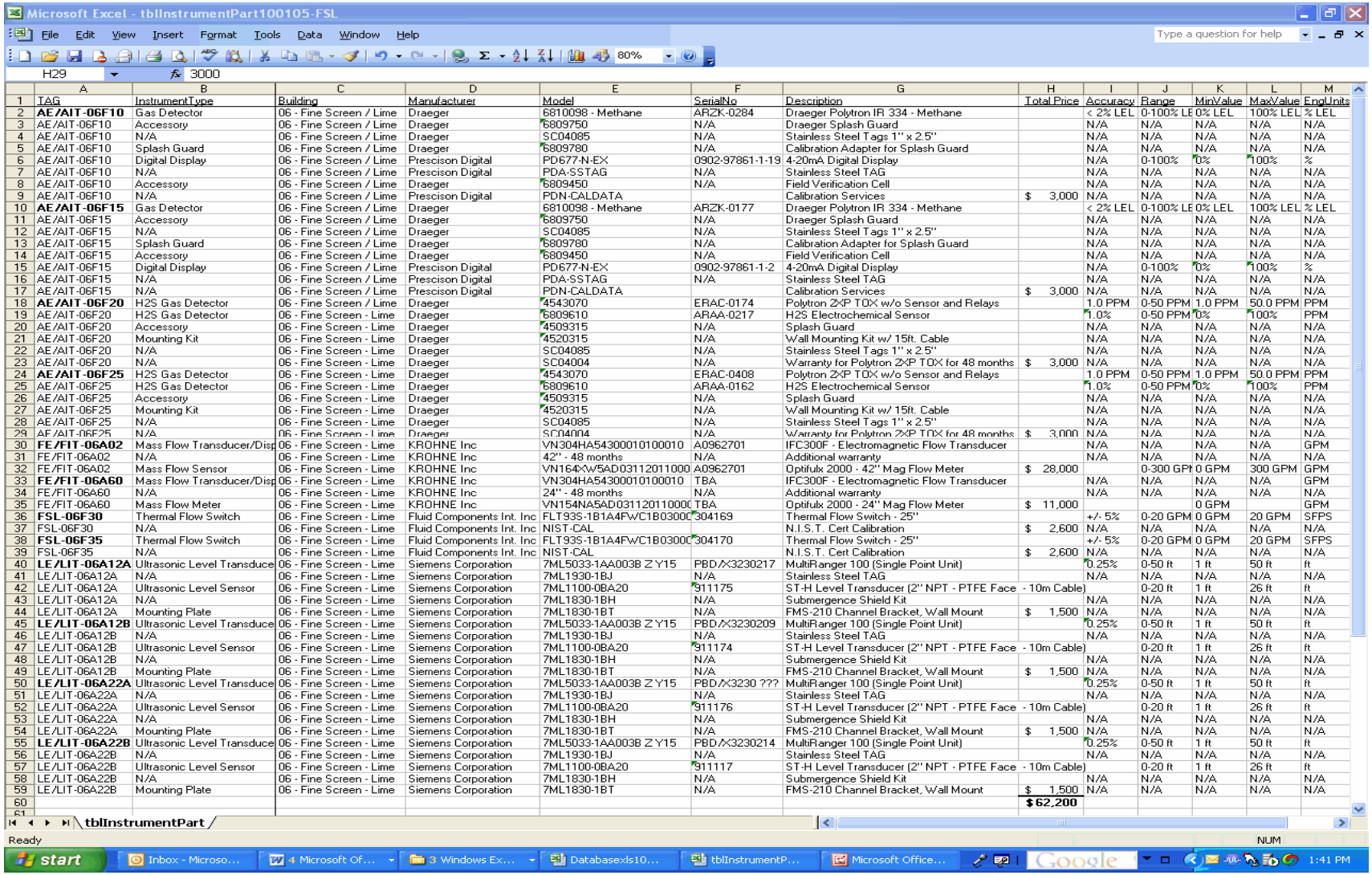

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	A	B	C	D	E	F	G	H	I	J	K	L	M
1	TAG	InstrumentType	Building	Manufacturer	Model	SerialNo	Description	Total Price	Accuracy	Range	MinValue	MaxValue	EngUnits
2	**AE/AIT-06F10**	Gas Detector	06 - Fine Screen / Lime	Draeger	6810098 - Methane	ARZK-0284	Draeger Polytron IR 334 - Methane		< 2% LEL	0-100% LE	0% LEL	100% LEL	% LEL
3	AE/AIT-06F10	Accessory	06 - Fine Screen / Lime	Draeger	6809750	N/A	Draeger Splash Guard		N/A	N/A	N/A	N/A	N/A
4	AE/AIT-06F10	N/A	06 - Fine Screen / Lime	Draeger	SC04085	N/A	Stainless Steel Tags 1" x 2.5"		N/A	N/A	N/A	N/A	N/A
5	AE/AIT-06F10	Splash Guard	06 - Fine Screen / Lime	Draeger	6809780	N/A	Calibration Adapter for Splash Guard		N/A	N/A	N/A	N/A	N/A
6	AE/AIT-06F10	Digital Display	06 - Fine Screen / Lime	Prescison Digital	PD677-N-EX	0902-97861-1-19	4-20mA Digital Display		N/A	0-100%	0%	100%	%
7	AE/AIT-06F10	N/A	06 - Fine Screen / Lime	Prescison Digital	PDA-SSTAG	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
8	AE/AIT-06F10	Accessory	06 - Fine Screen / Lime	Draeger	6809450	N/A	Field Verification Cell		N/A	N/A	N/A	N/A	N/A
9	AE/AIT-06F10	N/A	06 - Fine Screen / Lime	Prescison Digital	PDN-CALDATA		Calibration Services	$ 3,000	N/A	N/A	N/A	N/A	N/A
10	**AE/AIT-06F15**	Gas Detector	06 - Fine Screen / Lime	Draeger	6810098 - Methane	ARZK-0177	Draeger Polytron IR 334 - Methane		< 2% LEL	0-100% LE	0% LEL	100% LEL	% LEL
11	AE/AIT-06F15	Accessory	06 - Fine Screen / Lime	Draeger	6809750	N/A	Draeger Splash Guard		N/A	N/A	N/A	N/A	N/A
12	AE/AIT-06F15	N/A	06 - Fine Screen / Lime	Draeger	SC04085	N/A	Stainless Steel Tags 1" x 2.5"		N/A	N/A	N/A	N/A	N/A
13	AE/AIT-06F15	Splash Guard	06 - Fine Screen / Lime	Draeger	6809780	N/A	Calibration Adapter for Splash Guard		N/A	N/A	N/A	N/A	N/A
14	AE/AIT-06F15	Accessory	06 - Fine Screen / Lime	Draeger	6809450	N/A	Field Verification Cell		N/A	N/A	N/A	N/A	N/A
15	AE/AIT-06F15	Digital Display	06 - Fine Screen / Lime	Prescison Digital	PD677-N-EX	0902-97861-1-2	4-20mA Digital Display		N/A	0-100%	0%	100%	%
16	AE/AIT-06F15	N/A	06 - Fine Screen / Lime	Prescison Digital	PDA-SSTAG	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
17	AE/AIT-06F15	N/A	06 - Fine Screen / Lime	Prescison Digital	PDN-CALDATA		Calibration Services	$ 3,000	N/A	N/A	N/A	N/A	N/A
18	**AE/AIT-06F20**	H2S Gas Detector	06 - Fine Screen / Lime	Draeger	4543070	ERAC-0174	Polytron 2XP TOX w/o Sensor and Relays		1.0 PPM	0-50 PPM	1.0 PPM	50.0 PPM	PPM
19	AE/AIT-06F20	H2S Gas Detector	06 - Fine Screen - Lime	Draeger	6809610	ARAA-0217	H2S Electrochemical Sensor		1.0%	0-50 PPM	0%	100%	PPM
20	AE/AIT-06F20	Accessory	06 - Fine Screen - Lime	Draeger	4509315	N/A	Splash Guard		N/A	N/A	N/A	N/A	N/A
21	AE/AIT-06F20	Mounting Kit	06 - Fine Screen - Lime	Draeger	4520315	N/A	Wall Mounting Kit w/ 15ft. Cable		N/A	N/A	N/A	N/A	N/A
22	AE/AIT-06F20	N/A	06 - Fine Screen - Lime	Draeger	SC04085	N/A	Stainless Steel Tags 1" x 2.5"		N/A	N/A	N/A	N/A	N/A
23	AE/AIT-06F20	N/A	06 - Fine Screen - Lime	Draeger	SC04004	N/A	Warranty for Polytron 2XP TOX for 48 months	$ 3,000	N/A	N/A	N/A	N/A	N/A
24	**AE/AIT-06F25**	H2S Gas Detector	06 - Fine Screen - Lime	Draeger	4543070	ERAC-0408	Polytron 2XP TOX w/o Sensor and Relays		1.0 PPM	0-50 PPM	1.0 PPM	50.0 PPM	PPM
25	AE/AIT-06F25	H2S Gas Detector	06 - Fine Screen - Lime	Draeger	6809610	ARAA-0162	H2S Electrochemical Sensor		1.0%	0-50 PPM	0%	100%	PPM
26	AE/AIT-06F25	Accessory	06 - Fine Screen - Lime	Draeger	4509315	N/A	Splash Guard		N/A	N/A	N/A	N/A	N/A
27	AE/AIT-06F25	Mounting Kit	06 - Fine Screen - Lime	Draeger	4520315	N/A	Wall Mounting Kit w/ 15ft. Cable		N/A	N/A	N/A	N/A	N/A
28	AE/AIT-06F25	N/A	06 - Fine Screen - Lime	Draeger	SC04085	N/A	Stainless Steel Tags 1" x 2.5"		N/A	N/A	N/A	N/A	N/A
29	AE/AIT-06F25	N/A	06 - Fine Screen - Lime	Draeger	SC04004	N/A	Warranty for Polytron 2XP TOX for 48 months	$ 3,000	N/A	N/A	N/A	N/A	N/A
30	**FE/FIT-06A02**	Mass Flow Transducer/Disp	06 - Fine Screen - Lime	KROHNE Inc	VN304HA54300010100010	A0962701	IFC300F - Electromagnetic Flow Transducer		N/A	N/A	N/A	N/A	GPM
31	FE/FIT-06A02	N/A	06 - Fine Screen - Lime	KROHNE Inc	42" - 48 months	N/A	Additional warranty		N/A	N/A	N/A	N/A	N/A
32	FE/FIT-06A02	Mass Flow Sensor	06 - Fine Screen - Lime	KROHNE Inc	VN164XW5AD03112011000	A0962701	Optiflux 2000 - 42" Mag Flow Meter	$ 28,000		0-300 GPI	0 GPM	300 GPM	GPM
33	**FE/FIT-06A60**	Mass Flow Transducer/Disp	06 - Fine Screen - Lime	KROHNE Inc	VN304HA54300010100010	TBA	IFC300F - Electromagnetic Flow Transducer		N/A	N/A	N/A	N/A	GPM
34	FE/FIT-06A60	N/A	06 - Fine Screen - Lime	KROHNE Inc	24" - 48 months	N/A	Additional warranty		N/A	N/A	N/A	N/A	N/A
35	FE/FIT-06A60	Mass Flow Meter	06 - Fine Screen - Lime	KROHNE Inc	VN154NA5AD03112011000	TBA	Optiflux 2000 - 24" Mag Flow Meter	$ 11,000			0 GPM		GPM
36	**FSL-06F30**	Thermal Flow Switch	06 - Fine Screen - Lime	Fluid Components Int. Inc	FLT93S-1B1A4FWC1B03000	304169	Thermal Flow Switch - 25"		+/- 5%	0-20 GPM	0 GPM	20 GPM	SFPS
37	FSL-06F30	N/A	06 - Fine Screen - Lime	Fluid Components Int. Inc	NIST-CAL		N.I.S.T. Cert Calibration	$ 2,600	N/A	N/A	N/A	N/A	N/A
38	**FSL-06F35**	Thermal Flow Switch	06 - Fine Screen - Lime	Fluid Components Int. Inc	FLT93S-1B1A4FWC1B03000	304170	Thermal Flow Switch - 25"		+/- 5%	0-20 GPM	0 GPM	20 GPM	SFPS
39	FSL-06F35	N/A	06 - Fine Screen - Lime	Fluid Components Int. Inc	NIST-CAL		N.I.S.T. Cert Calibration	$ 2,600	N/A	N/A	N/A	N/A	N/A
40	**LE/LIT-06A12A**	Ultrasonic Level Transduce	06 - Fine Screen - Lime	Siemens Corporation	7ML5033-1AA003B Z Y15	PBD/X3230217	MultiRanger 100 (Single Point Unit)		0.25%	0-50 ft	1 ft	50 ft	ft
41	LE/LIT-06A12A	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1930-1BJ	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
42	LE/LIT-06A12A	Ultrasonic Level Sensor	06 - Fine Screen - Lime	Siemens Corporation	7ML1100-0BA20	911175	ST-H Level Transducer (2" NPT - PTFE Face	- 10m Cable)		0-20 ft	1 ft	26 ft	ft
43	LE/LIT-06A12A	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BH	N/A	Submergence Shield Kit		N/A	N/A	N/A	N/A	N/A
44	LE/LIT-06A12A	Mounting Plate	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BT	N/A	FMS-210 Channel Bracket, Wall Mount	$ 1,500	N/A	N/A	N/A	N/A	N/A
45	**LE/LIT-06A12B**	Ultrasonic Level Transduce	06 - Fine Screen - Lime	Siemens Corporation	7ML5033-1AA003B Z Y15	PBD/X3230209	MultiRanger 100 (Single Point Unit)		0.25%	0-50 ft	1 ft	50 ft	ft
46	LE/LIT-06A12B	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1930-1BJ	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
47	LE/LIT-06A12B	Ultrasonic Level Sensor	06 - Fine Screen - Lime	Siemens Corporation	7ML1100-0BA20	911174	ST-H Level Transducer (2" NPT - PTFE Face	- 10m Cable)		0-20 ft	1 ft	26 ft	ft
48	LE/LIT-06A12B	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BH	N/A	Submergence Shield Kit		N/A	N/A	N/A	N/A	N/A
49	LE/LIT-06A12B	Mounting Plate	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BT	N/A	FMS-210 Channel Bracket, Wall Mount	$ 1,500	N/A	N/A	N/A	N/A	N/A
50	**LE/LIT-06A22A**	Ultrasonic Level Transduce	06 - Fine Screen - Lime	Siemens Corporation	7ML5033-1AA003B Z Y15	PBD/X3230 ???	MultiRanger 100 (Single Point Unit)		0.25%	0-50 ft	1 ft	50 ft	ft
51	LE/LIT-06A22A	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1930-1BJ	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
52	LE/LIT-06A22A	Ultrasonic Level Sensor	06 - Fine Screen - Lime	Siemens Corporation	7ML1100-0BA20	911176	ST-H Level Transducer (2" NPT - PTFE Face	- 10m Cable)		0-20 ft	1 ft	26 ft	ft
53	LE/LIT-06A22A	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BH	N/A	Submergence Shield Kit		N/A	N/A	N/A	N/A	N/A
54	LE/LIT-06A22A	Mounting Plate	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BT	N/A	FMS-210 Channel Bracket, Wall Mount	$ 1,500	N/A	N/A	N/A	N/A	N/A
55	**LE/LIT-06A22B**	Ultrasonic Level Transduce	06 - Fine Screen - Lime	Siemens Corporation	7ML5033-1AA003B Z Y15	PBD/X3230214	MultiRanger 100 (Single Point Unit)		0.25%	0-50 ft	1 ft	50 ft	ft
56	LE/LIT-06A22B	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1930-1BJ	N/A	Stainless Steel TAG		N/A	N/A	N/A	N/A	N/A
57	LE/LIT-06A22B	Ultrasonic Level Sensor	06 - Fine Screen - Lime	Siemens Corporation	7ML1100-0BA20	911117	ST-H Level Transducer (2" NPT - PTFE Face	- 10m Cable)		0-20 ft	1 ft	26 ft	ft
58	LE/LIT-06A22B	N/A	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BH	N/A	Submergence Shield Kit		N/A	N/A	N/A	N/A	N/A
59	LE/LIT-06A22B	Mounting Plate	06 - Fine Screen - Lime	Siemens Corporation	7ML1830-1BT	N/A	FMS-210 Channel Bracket, Wall Mount	$ 1,500	N/A	N/A	N/A	N/A	N/A
60								**$ 62,200**					

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END OF SECTION

SECTION 01800

MAINTENANCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Contractor will be required to maintain stored and installed equipment and materials until Final Acceptance of the Work as defined by the General Conditions. Work included, but is not limited to:
   1. Perform all required maintenance.
   2. Repair and maintain protective coatings.
   3. Repair and replace scratched and damaged materials and equipment.
   4. Maintain and operate new equipment placed into service.

B. Work per this Section starts on the date the equipment and materials are received and continues until the Date of Final Acceptance.

C. Contractor will monitor equipment storage and subsequently the operation and material functionality on a continual basis during the specified time period. Any deterioration of materials or malfunction of equipment will be followed by swift repair action to minimize the damage. Such repair may include repair and technical services by an independent contractor if the Engineer deems the Contractor's efforts are ineffective in correcting the problem.

D. All costs for maintenance and repair of stored and installed equipment and materials, including costs from an independent contractor, during the specified time period will be the sole responsibility of the Contractor.

END OF SECTION

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DIVISION 2

SITEWORK

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SECTION 02000

SITE WORK

PART 1 - GENERAL

1.1 DESCRIPTION

These general site work requirements apply to all site work operations. Refer to specification sections for specific product and execution requirements.

1.2 QUALITY ASSURANCE

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.

1.3 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 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 bench marks, 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 shall be at Contractor's expense.

I. Protect and maintain street lights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mail boxes with the applicable governmental agency. Provide for temporary relocation when required to maintain facilities and services in operation during construction work.

J. Preserve from injury or defacement all vegetation and objects designated to remain.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Materials and equipment: As selected by Contractor, except as indicated in contract documents.

PART 3 - EXECUTION

3.1 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

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.1 SCOPE

A. The work covered under this Section includes furnishing all labor, equipment and material required to remove, handle, crush and dispose of all equipment, materials and piping as shown on the Drawings, as directed by the Engineer or required for the completion of the Work, including all necessary excavation and backfilling.

B. Where structural tile and brick are removed 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.

C. 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 reconcreting, dressing and finishing of openings to the required lines and dimensions or as necessary for the placing and fixing of inserts.

D. 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 which are indicated to be removed or demolished per contract documents.

E. The work specified herein and shown on the Drawings is intended to give a general idea of the scope of this work but must 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.

F. Requirements for removal of pavement and abandonment of site utilities are specified in Section 02200.

G. Buildings, facilities, and utilities to be selectively demolished are shown on the drawings.

H. Many obstructions are not shown on the Drawings. Bidders are advised to carefully inspect the existing facilities before preparing the Bid Proposal. This Contract shall include removal and replacement of obstructions such

as electrical conduits and wire; water and waste piping; and similar items which may interfere with or hinder installation of equipment or materials; construction; or demolition required under the scope of the project. The Contractor shall coordinate all such demolition with Section 01100.

1.2 SUBMITTALS

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

A. The Contractor shall submit to the Engineer, prior to beginning work, a schedule of demolition and detail methods to be used on each facility to be demolished.

B. The Contractor shall develop and submit a demolition plan which includes a demolition schedule comparable to a room finish schedule that covers:
   1. Each building surface affected by demolition.
   2. Proposed method and materials for demolition and patching.
   3. Catalog cuts and samples of the materials to be used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Contractor shall provide all materials and equipment in suitable and adequate quantity as required to accomplish the work shown, specified herein, and as required to complete the project.

B. All concrete, mortar, grout, and backfill used in patching, plugging or repairing shall comply in all respects with the applicable material requirements of these Specifications.

C. Tile and brick used for the patching of existing masonry shall be of the same size, color and texture as the tile and brick which they abut. Salvageable tile and brick units which are removed in performing the required alterations may be reused if the exposed faces and edges of the units are in good condition. If satisfactory units are unobtainable through salvage operations, the Contractor shall furnish the required units of new material of similar quality, color and texture.

PART 3 - EXECUTION

3.1 GENERAL

A. Shutdown of Existing Operations and Utilities

1. The existing Combined Sewer Overflow Control Facility is required to remain in service during construction of the new and modification of the existing facilities.
2. Total shutdown of the existing facilities to perform any new construction, to make the required structural or piping modifications, and, and/or to make or install the required electrical service or system modifications, will not be permitted and partial shutdown of the various existing facilities will be permitted as defined in Section 01011.
3. Prior to making any piping or structural connections or modifications to existing facilities, obtain specified timing and schedule approval.

B. Protection

1. Take care to prevent the spread of dust and flying particles. Sprinkle rubbish and debris with water to keep dust to a minimum.
2. Maintain adequate fire protection, including extinguisher and operative water-hose lines during demolition.

C. Personnel: Perform work by personnel experienced in this type work and in such a manner as to eliminate hazards to persons and property without interference with new work and with use of adjacent areas, public rights-of-way, utilities and structures.

3.2 CONCRETE DEMOLITION

A. Remove concrete using hand held equipment unless otherwise approved by the Engineer. All necessary precautions shall be taken during removal of concrete to prevent debris from falling and damaging adjacent piping, equipment, and facilities.

B. Where partial removal of a wall or floor is required, score the edge of the area to be removed (on all exposed surfaces) by saw cutting clean, straight lines to minimum 1 inch depth, but not greater than the depth of cover over the existing reinforcing steel and then chipping out the concrete. Saw cuts shall not extend beyond the limits of the opening. Corners shall be made true and square by combination of core drilling, chipping and grinding as necessary.

C. Where new concrete will be placed against a removal surface, preserve intact the existing reinforcing steel that would/will project into the new concrete. Allow the existing bars to project one lap length into the new concrete, or where this is not possible, weld new bars to the existing bars.

Welds shall develop the full strength of the existing bars. Welding shall comply with ASTM A 706.

D. Where specifically shown or where the surface will be exposed, the removal may be accomplished by saw cutting completely through the concrete. The concrete around any exposed reinforcing steel shall be chipped back and the exposed reinforcing steel cut a minimum of 1-½-inches back from the finished face of the concrete. The face of the new concrete surface shall be grouted to fill all the depressions at cut reinforcing and any other voids and to cover the exposed aggregate and shall be trowel finished. Non-shrink grout shall be used as directed by the Engineer. Except as otherwise noted or required, concrete pads and bases for equipment and supports which are on grade shall be removed to a depth 6 inches below finished grade or 6 inches below the bottom of any new slab to be placed over it.

E. Where concrete surfaces must be repaired, such as where removal of existing equipment pads or other demolition activity leaves a rough surface, they shall be repaired using a two component latex modified concrete bonded overlay. The materials, surface preparation and application shall be as recommended by Sika Corporation, Lyndhurst, N.J.; or Master Builders, Cleveland, Ohio; and as acceptable to the Engineer. In addition, the following requirements shall apply:

1. All edges of the repair area shall be cut vertical or slightly undercut to a ½-inch minimum depth and to wedge in the patch. No feather edges will be allowed. All edges shall be neat and straight.
2. Remove concrete as necessary to create a minimum thickness patch of ½-inch, but not less than the minimum thickness recommended by the manufacturer.
3. Concrete around exposed reinforcing bars shall be removed to a minimum of ¾-inch below the steel.
4. The concrete surface to receive the overlay shall be roughened to a 3/16 inch profile, sandblasted to open the pores of the concrete, and cleaned of all loose material and laitance. Acid etch as necessary to remove any contaminants.
5. A bonding grout, as recommended by the manufacturer, shall be uniformly brushed onto the surface, thoroughly coating all existing concrete and steel surfaces. Place the bonding grout only a few feet in front of the overlay concrete placement.
6. The overlay shall be moist cured.
7. Finish the overlay surface to be continuous with and to match the surrounding concrete surface.

F. Preserving Existing Reinforcing: Where holes or openings are to be cut in existing concrete, preserve intact existing steel reinforcing. Where existing reinforcing must be removed, and where directed by the Engineer, new bars of sufficient size shall be spliced in and around the objects to be

inserted in the opening. Such shall be welded to the ends of existing bars. Welds shall be of such size and length as to develop the full strength of the existing bars.

3.3 MASONRY DEMOLITION

A. Existing masonry to be removed shall be broken by air hammer and chisel in such manner as to leave adjoining portions of the structure in an undisturbed condition. In removing existing masonry, special care shall be taken to cut it as closely as possible to the required shape and with no projection into the neat outside line of the new work. The surfaces of all concrete and masonry shall be sufficiently rough to bond well with the new work.

B. Contractor shall remove masonry within the limits of the opening or penetration to the nearest complete undamaged brick. Completed demolition of a masonry opening or penetration shall have no saw cut, chipped or otherwise damaged brick on its perimeter.

C. Before any new masonry is built on or against existing concrete or masonry, the latter shall be scrupulously freed from all dirt, gravel, boulders, ice, snow or other objectionable substances.

D. Existing reinforcement shall lap the reinforcement in the new masonry as shown on the Drawings or as directed by the Engineer.

3.4 REMOVAL OF EXISTING EQUIPMENT AND PIPING

A. Equipment specified to be removed shall be removed completely, including all related accessories and concrete bases. Any embedded items such as anchor bolts, steel reinforcement, conduit and piping shall be cut off 1 inch below adjacent finished surfaces. The surface shall then be repaired to match adjacent surfaces in finish and appearance.

B. Prior to removing any electrical equipment, all power to the equipment shall be shut off and properly locked out. All power and control wiring for the equipment shall then be disconnected at the starter or circuit breaker, as applicable, and removed from the conduit. Unused conduits shall be plugged.

C. Blemishes or unsightly areas on walls and floors left after removal of equipment shall be cleaned and refinished as necessary to match adjacent surfaces.

D. All holes and openings left after removal of equipment shall be filled or plugged to provide a neat and workmanlike appearance.

E. Where piping designated for removal passes through concrete walls, the openings shall be suitably plugged or capped. Wall pipes and wall sleeves shall be sealed with blind flanges or mechanical joint plugs. Steel pipe sleeves shall be filled with non-shrink grout.

F. Where equipment or piping designated for removal serves to support other equipment or piping designated to remain in service, the Contractor shall provide permanent supports in place of the removed equipment and piping. Where it is necessary to temporarily remove other equipment, piping or electrical work in order to gain access to an item of equipment or piping designated for removal, the Contractor shall restore all such equipment, piping or electrical work to its original condition.

G. Abandoned Piping: Existing vitrified clay, concrete, PVC, cast iron and steel piping to be abandoned shall be cut and plugged or capped at each end. Where existing piping interferes with new piping or construction, it shall be removed beyond the limits required for the proper completion of the work and the open ends plugged or capped unless otherwise shown, lines shall be plugged or capped at least 1 inch behind or below finished building surfaces, and at least 12 inches below outside grade surfaces.

H. Piping and Valving Reinstallation: The Contractor shall include in the Contract Price the cost of removing, refitting, and reinstalling certain pipe, fittings, and valves as shown on the Drawings.

3.5 PROTECTION OF WORK AND EXISTING FACILITY

A. Perform the work in a manner that will not damage parts of the structure, facility, or system not intended to be removed. If in the opinion of the Engineer, the method of demolition or cutting may endanger or damage parts of the structure(s) or affect the operation of the facilities, promptly change the method when so notified by the Engineer. Perform all cutting required regardless whether such cutting is specifically indicated. Examine the existing structures, evaluate conditions to be encountered in accomplishing the work, and accommodate such requirements accordingly in the Bid Proposal. No blasting will be permitted.

B. The Contractor shall exercise full care and shall use such methods and equipment during removal as well as maintain the usefulness of the various materials and equipment removed.

C. Any damage done to structures or equipment during removal and any patching, plugging of holes or repairs necessitated because of removal of equipment and piping shall be repaired to the satisfaction of the Engineer and the cost thereof shall be included in the Contract Price.

3.6 DISPOSAL

A. Disposal: All rubble and waste material shall be removed from each work area in order to provide a clean area for plant operations. Such removal and cleanup is to be completed upon conclusion of daily work, outage period, or a specific work period. Removal of waste material from the work areas constitutes physical removal of the debris, rubble, or waste from the building proper or work site to a proper storage container or stockpile. If material is stockpiled for later disposal, the stockpile location shall be as approved by the Engineer. Should stockpiling not be approved, an appropriate container may be used, or the Contractor may dispose of the material directly. If stockpiling is approved, disposal of stockpiled materials shall be accomplished at a frequency no less than weekly. Waste containers shall be located as approved by the Engineer. Waste material is considered to be any item or material that is removed from an existing condition and is not intended for reinstallation or salvage to the City. The Contractor shall be fully responsible for proper disposal of waste materials in accordance with all federal, state and local laws at no additional cost to the City.

B. Contractor shall not dispose of any trash, material, equipment or litter into water reclamation center facilities or tanks. Contractor shall be responsible for any damage to any facilities, tanks or equipment by any such foreign material.

3.7 DISPOSITION OF SALVAGEABLE MATERIALS

A. The Contractor shall submit a listing of all equipment which is shown to be removed, replaced or demolished, as indicated on the drawings which is in salvageable condition to the City for approval. Upon approval by the Engineer, the equipment approved as salvageable is to be salvaged and delivered to the City at a location to be designated at the project ¬site by the Engineer. Equipment that shall be included in the listing includes (but is not limited to) pumps, valves, valve actuators, and instruments. Chemical PVC piping and FRP tanks are not to be considered for salvage. Loading and unloading shall be the responsibility of the Contractor.

B. Equipment, as defined above, which is potentially salvageable shall be removed with care so as not to damage it for possible future use. Equipment shall be protected from dirt and the elements. Damage caused by the Contractor to equipment or material specified herein or indicated on the Drawings to be salvaged shall be replaced or repaired by the Contractor at no additional cost to the City. Reuse by the Contractor of salvaged material will not be permitted, except as specifically shown, specified herein, or as approved by the Engineer.

3.8 REHABILITATION

Certain areas of existing structures, piping, conduits and the like may be affected by work necessary to complete the modifications. The Contractor is responsible to rehabilitate those areas affected by the construction activities. Where existing equipment, equipment pads and bases, piping, piping supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected areas such that little or no evidence of the previous installation remains. Remaining openings in concrete floors, walls, and ceilings from piping, conduit, and fasteners shall be filled with non-shrink grout and finished to match the adjacent area.

END OF SECTION

SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 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 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 02050, Demolition.
3. Section 02125, Temporary and Permanent Erosion and Sedimentation Control.
4. Section 02200, Earthwork.

1.2 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 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 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 City. Replace damaged trees that cannot be repaired and restored to full-growth status, as determined by the Engineer.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXISTING TREES AND VEGETATION

Avoid cutting or injuring trees and vegetation outside easement line and outside areas to be cleared. Contractor shall be responsible for damages outside these lines.

3.2 CLEARING AND GRUBBING

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 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 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, and 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 into maximum size which can be handled

without tearing or stripping the sod and underlying topsoil. The sod shall be stockpiled 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.

3.2 HOLES AND DEPRESSIONS

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. Place fill material in horizontal layers not exceeding six inches loose-depth and compact to a 95 percent standard Proctor.

3.3 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. On-Site Disposal:
1. When authorized by the Engineer, cut tree trunks and limbs, over two inches in diameter, into 48 inch lengths and neatly stack within work limits on the same property as that on which the tree originally grew.
2. On undeveloped property, distribute brush, trees and limbs less than two inches in diameter, within the work area from which cut, as directed by the Engineer. On developed property, remove all such clearing waste and properly dispose of it off-site.

C. The debris resulting from the clearing and grubbing operation shall be hauled to a disposal site secured by the Contractor and shall be disposed of in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or in any street or alley. No debris shall be deposited upon any private property except with written consent of the property owner. In no case shall any material or debris be left on the project site, shoved onto abutting private properties, or buried on the project site.

3.4 CONSTRUCTION ACCESS ROUTE ON EASEMENT

A. When shown on the Drawings, or directed by the Engineer, a construction access route shall be built on the an 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.

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 and submit a tree removal and disposal plan to the Engineer.

B. The Engineers written approval shall be obtained prior to the removal of any trees from the easement

C. All trees that need further processing (wood chips) on-site or disposal off-site must be processed or disposed of in conformance with federal, state, and local rules and regulations.

D. Contractor must acquire any additional permits prior to commencement of any type of work done in the easement

E. Stemmed vegetation such as brush, shrubs, and trees as necessary shall be removed at or near the ground level, leaving the root systems intact.

F. Trees shall be felled into the cleared construction area or areas to be cleared and not onto vegetation to be preserved.

G. Trees that have fallen into water bodies, or beyond the construction area, shall be removed immediately.

+++END OF SECTION+++

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SECTION 02115
CLEANING OF EXISTING PIPES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to clean pipelines, laterals and manholes.

B. The cleaning Work required includes, but is not limited to, the following:

1. Normal and heavy cleaning of existing sanitary sewers and laterals.
2. Cutting of roots, grease, intruding sealing ring material and objects wedged in pipe joints from existing sanitary sewers and laterals.
3. Removal of debris from sewers, manholes and laterals.
4. Pressure washing of manhole walls, rungs, channel and bench.
5. Disposal of waste and sediment.
6. Cleaning up as the Work progresses and after the completion of all Work activities.
7. All other Work required for the complete and satisfactory cleaning of the pipelines, laterals and manholes.

1.2 DEFINITIONS

A. Normal cleaning – cleaning accomplished using water jets to scour and remove debris, grease, etc. from pipe and manhole in 1 to 3 complete passes of the nozzle.

B. Root cutting and grease cutting – removal of roots larger than fine roots (as defined by PACP), hardened grease and intruding sealing ring material using cutting device.

C. Heavy cleaning – cleaning accomplished using water jets to scour and remove debris, grease, etc. from pipe.

1.3 RELATED SECTIONS

Section 01500, Temporary Facilities.

1.4 GENERAL PRECAUTIONS

A. Take precautions to protect sewer mains, laterals and manholes from damage that might be inflicted by the improper selection of the cleaning process or improper use of the equipment.

B. When using hydraulically propelled devices, take precautions to ensure that the water pressure created does not cause damage or flooding to public or private property.

C. Do not surcharge the sewer beyond the elevation that could cause overflow of sewage.

D. Restore or repair any facility, which is damaged by CONTRACTOR actions at no cost to OWNER.

1.5 SUBMITTALS

A. Specifications of the sewer cleaning equipment, including performance data on pump(s), hose diameter and length, tank capacity, and intended nozzles, root cutters, and debris baskets to be used on the job. Provide a chart that shows hose length and diameter versus volume and pressure.

B. Lateral root removal and cleaning equipment (if applicable).

C. Specifications on the equipment to be used to remove sediment and debris at the downstream manhole of each reach to be cleaned. Plan for disposal of debris and sediment removed from the cleaned pipelines, manholes and laterals.

1.6 QUALIFICATIONS

CONTRACTOR shall have experience in the cleaning of sewers. Documentation of experience shall be furnished to the ENGINEER upon request.

PART 2 - PRODUCTS

2.1 MAINLINE SEWER AND LATERAL CLEANING EQUIPMENT

A. Cleaning equipment shall consist of truck-mounted, high velocity hydro-cleaning equipment. The equipment shall be provided with a minimum of 500 feet of one-inch inner diameter high-pressure hose with a selection of high velocity nozzles, as required for the cleaning operation. The various nozzles shall produce a scouring action from 10 to 45 degrees in all size sewers to be cleaned. Use

nozzles matched to the pumps and the site-specific cleaning requirements. Mount all nozzles with skids. A tiger tail or boot or downhole roller is required. A pressure gauge shall show operating pressure and a flow meter shall show flow rate. A table to translate shown pressures to delivery pressure shall accompany each cleaner unit.

B. The pumps shall be capable of delivering a minimum 60 gpm at 2,000 psi at the nozzle head. A relief valve shall regulate pressure to the nozzle. The unit shall carry its own water tank, minimum of 1,000 gallons, auxiliary engines and pumps, and a hydraulically-driven hose reel.

C. All controls shall be located so that the equipment can be operated above ground.

D. Include appropriate adaptors, hoses and nozzles for cleaning laterals from mainline sewer. If utilizing an existing cleanout to clean lateral, provide equipment suitable for launching through cleanout to clean lateral.

2.2 MANHOLE CLEANING EQUIPMENT

Provide a high velocity washing hose for cleaning of the walls, rungs, channel and bench of the manhole. The hose shall have an adjustable nozzle capable of producing flow from a fine spray to a solid stream. All controls shall be located so that the equipment can be operated above ground.

2.3 VACUUM EQUIPMENT

A. Provide equipment capable of removing all sand, dirt, rocks, roots, and other debris from the sewer and manhole.

B. Provide screens to prevent scoured debris from migrating downstream of the limits of the Work.

2.4 CUTTING EQUIPMENT

Provide equipment that can mechanically cut roots and grease from lateral. For laterals without cleanouts, provide appropriate equipment that can be launched from the main to remove roots.

2.5 FLUSHING/CLEANING WATER

Provide all flushing water required for the cleaning of sewers either by truck or by an agreement with a potable water distribution system entity in

accordance with Section 01500, Temporary Facilities, or in accordance with surface water removal requirements. Provide proof that all flushing water was acquired lawfully.

2.6 DEBRIS BASKETS

Provide debris buckets with ¼" hole pattern or smaller sized to fit into the pipe being cleaned.

PART 3 - EXECUTION

3.1 MAINLINE SEWER CLEANING

A. Thoroughly clean all pipeline reaches in order to permit an unrestricted inspection by closed circuit television. Particular emphasis shall be afforded to the removal of accumulated grease, roots, sand, rocks, sludge and other debris so that the video inspection will show clearly all portions of the pipe being inspected. Pressure at the nozzle shall be between 1500 psi and 2000 psi and flow rate shall be between 60 gpm and 75 gpm during cleaning operations in the sewer, unless otherwise approved by the ENGINEER. A lower pressure shall be used in areas known to be subject to backups through the laterals.

B. Clean upstream reaches of sewers before the downstream reaches.

C. Insert cleaning equipment into the downstream manhole of a given reach and pull the debris downstream. Reverse setups may be used if all debris is removed (i.e., no material is passed to the adjacent pipe segment).

D. In mainlines, at a minimum, make one pass with a 30º - 45º nozzle at a rate not greater than 20 feet per minute, and one pass with a 10º - 15º nozzle at a rate not greater than 30 feet per minute. Reduce pressures and increase pull back rates in consultation with ENGINEER when cleaning through holes, breaks, and partial collapses in pipe so as to effectively clean pipe but minimize further damage pipe integrity.

E. Rig winching equipment so as not to damage the existing pipeline or manholes.

F. Continuously observe flow from cleaning operations. If any evidence of clean sand, dirt, or pipe bedding stone or of pipe

fragments are observed, decrease jetting pressures, move nozzle away from likely source areas, and insert camera into sewer to observe pipe conditions that might be contributing to these observations to minimize damage to pipe integrity caused by jetting operations. Alter cleaning pressures, pullback rates, and nozzles types to minimize potential for damage in consultation with ENGINEER.

G. During cleaning, restrict the flow level in the pipe to a maximum of 30 percent of the pipe diameter. Take particular care to avoid flooding house connections during cleaning operations.

H. Remove any blockages of lateral building connections resulting from the cleaning or other items of Work by cleaning of the building connection at no additional cost to the OWNER.

3.2 MANHOLE CLEANING

Wash the wall, bench, channel and rungs of the manhole to remove accumulated debris, grease, sediment, and grit.

3.3 ROOT, GREASE AND INTRUDING SEAL MATERIAL REMOVAL

A. Remove all roots that could prevent the sealing of a packer, the proper application of chemical sealants or installation of a cured-in-place liner. Remove roots by suitable mechanical cutting devices or by hydraulic procedures such as with high-pressure jet cleaners. No roots of length greater than one and a half inches (1½-inch) shall remain following root removal procedures.

B. Remove all grease which could prevent the sealing of a packer, the proper application of chemical sealants, or the installation of a cured-in-place liner. Use suitable mechanical cutting devices to remove grease.

C. Remove objects wedged in pipe joints and intruding sealing ring material that interferes with the rehabilitation of sewer lines.

3.4 LATERAL CLEANING AND ROOT CUTTING

Remove accumulated grease, roots, sand, rocks, sludge and other debris so that the video inspection will clearly show all portions of the pipe being inspected.

3.5 DEBRIS REMOVAL

A. Insert debris baskets into manholes toward which jetted flow is pushed. Record volume of debris removed. Where appropriate, utilize vacuum to remove solids.

B. Remove all bricks, rocks, debris, sludge, dirt, sand, grease, roots, and other materials from the sewers and collect and remove the resulting debris from the downstream manholes of the sewer sections being cleaned. Utilize control measures in downstream manholes as necessary to prevent debris, sludge and other materials from passing through manholes to a downstream sewer section not scheduled for cleaning by CONTRACTOR that same day.

C. When removing materials from manholes, return the discharge and drainage liquid stream to the downstream sewer and discharge downstream for disposal. Under no circumstances shall sewage or solids be dumped onto the ground surface, street, stream, ditches, catch basins, or storm drains. All solids and semi-solids shall be placed in a watertight container so that no spillage or leakage will occur, covered to minimize odors, and disposed by the CONTRACTOR. The CONTRACTOR is responsible for all operations and costs associated with removal, transportation, and disposal of debris collected during the cleaning operations.

3.6 FIELD QUALITY CONTROL

Acceptance of pipeline cleaning shall be made upon the successful completion of the television inspection documenting that all required debris, roots, and grease are removed to the satisfaction of the ENGINEER. If television inspection shows debris, solids, sand, grease, or grit remaining in the line, re-clean and re-inspect the pipeline at no additional compensation.

END OF SECTION

SECTION 02125

TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SCOPE

A. Work under this section includes furnishing all labor, materials, equipment and incidentals required to install and maintain temporary and permanent erosion and sedimentation controls as shown on the Drawings and as specified herein. Work under this Section also includes the subsequent removal of temporary erosion and sedimentation controls at completion of the project.

B. Temporary and permanent erosion and sedimentation controls include mulching and grassing of disturbed areas and structural barriers at those locations which will ensure that erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by the Georgia Environmental Protection Division (EPD) and applicable codes, ordinances, rules, regulations and laws of local and municipal authorities having jurisdiction.

C. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. The Contractor shall notify the Engineer of any changes and/or additions to the erosion and sedimentation control measures necessary to accommodate the Contractor's means and methods of operation. Any additional erosion and sedimentation control measures required by the Contractor's means and methods of operation will be installed by the Contractor at no additional cost to the City.

D. The Contractor shall be solely responsible for the control of erosion and sediment production within the Project area. The Contractor shall install controls that will ensure that storm water and drainage from the disturbed area of the Project site will be filtered or otherwise managed to minimize impacts on receiving waters and/or existing storm drains. Discharged waters shall be free of soil particles and shall meet all applicable permit turbidity requirements.

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1.3 QUALITY ASSURANCE

A. The Contractor shall designate a worksite erosion control supervisor. The supervisor shall have the responsibility and authority to coordinate all equipment, personnel and materials needed to maintain project site erosion and sediment control in accordance with the management practices and standards established in the Manual for Erosion and Sediment Control in Georgia, the Drawings and Specifications.

B. Within 15 days after receipt of the Notice to Proceed, the Contractor shall submit the name and contact data for the designated erosion control supervisor. The supervisor shall be an individual with an active minimum Level 1 certification as issued by the Georgia Soil and Water Conservation Commission.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Silt fence: Silt fence shall be as detailed on the Drawings and shall meet the requirements of Section 171 – Silt Fence of the GDOT Department of Transportation Standard Specifications.
   1. Silt fence fabric shall conform to GDOT Standard Specification Section 881.2.07.
   2. Silt fencing shall conform to GDOT Standard Specification Section 894.
   3. Silt fence posts and bracing shall conform to GDOT Standard Specification Section 862.

B. Hay bales shall be clean, seed-free cereal hay type, rectangular in shape.

C. Woven wire fence backing shall be ½ inch, galvanized steel, chicken-wire mesh.

D. Filter stone shall be crushed rock conforming to Georgia Department of Transportation Table 800.01, Size Number 57.

E. Concrete block shall be hollow, non load bearing type.

F. Concrete shall be 3000 psi in accordance with Section 03300, Cast-in-Place Concrete.

G. Plywood shall be ¾ inch thick exterior type.

2.2 RIP RAP

A. Use only one method throughout the Project.

B. Stone Rip Rap shall consist of sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Rip rap shall have less than 66 percent wear when tested in accordance with AASHT0 T 96. Unless shown on the Drawings or specified otherwise, stone rip-rap shall be type 3.

1. Type 1 Rip Rap: The largest pieces shall have a maximum approximate volume of two cubic feet. At least 35 percent of the mass shall be comprised of pieces which weigh 125 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 1.
2. Type 3 Rip Rap: The largest pieces shall have a maximum approximate volume of one cubic foot. At least 35 percent of the mass shall be comprised of pieces which weigh 15 pounds or more. The remainder shall be well graded down to the finest sizes. Rock fines shall comprise a maximum of 10 percent of the total mass. Rock fines are defined as material passing a No. 4 sieve. Rip rap size shall conform to Georgia Department of Transportation Standard Specification Section 805 - Stone Dumped Rip Rap, Type 3.

2.3 FILTER FABRIC

Filter fabric for use under rip-rap shall meet the requirements of GDOT Standard Specification Section 881.2.05 for plastic filter fabric.

2.4 CONSTRUCTION EXIT STONE

Stone shall be sound, tough, durable stone resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Aggregate size shall be in accordance with the National Stone Association Size R-2 (1.5 to 3.5-inch stone) or Type 3 Riprap as specified in paragraph 2.02 of this Section.

2.5 GRASS

A. Permanent grass shall be of the same type that existed prior to construction.

B. Water: Water shall be free of excess and harmful chemicals, organisms and substances which may be harmful to plant growth or obnoxious to traffic. Salt or brackish water shall not be used. Water shall be furnished by the Contractor.

2.6 EROSION CONTROL FABRIC

Erosion control fabric shall be equal to Futerra Erosion Control Blanket manufactured by Profile Products LLC. Fabric shall be a non-woven erosion control/vegetation blanket comprised of wood fiber and crimped, interlocking synthetic fibers laminated by accelerated photodegradable polypropylene netting. Fabric shall be 100% bio-degradable and photo-degradable within 10 months of installation.

PART 3 - EXECUTION

3.1 GENERAL

A. Basic Principles:
   1. Conduct the earthwork and excavation activities in such a manner to fit the topography, soil type and condition.
   2. Minimize the disturbed area and the duration of exposure to erosion elements.
   3. Stabilize disturbed areas immediately.
   4. Safely convey run off from the site to a stable outlet.
   5. Retain sediment on site that is generated on site.
   6. Minimize encroachment upon watercourses.

B. Temporary Erosion and Sedimentation Control: Temporary erosion and sedimentation control procedures shall be directed toward:
   1. Preventing soil erosion at the source.
   2. Preventing silt and sediment from entering any waterway if soil erosion cannot be prevented.
   3. Preventing silt and sediment from migrating downstream in the event it cannot be prevented from entering the waterway.

C. Permanent Erosion Control: Permanent erosion control measures shall be implemented to prevent sedimentation of waterways and to prevent erosion of the Project site.

3.2 SEDIMENTATION AND EROSION CONTROL MEASURES

A. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the

opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.

B. All erosion and sedimentation control devices and structures shall be inspected by the Contractor at least once a week and immediately prior to and after each rainfall occurrence. Any device or structure found to be damaged shall be repaired or replaced by the end of the day. Sediment ponds shall be cleaned out prior to the silt reaching the height or elevation shown on the Drawings.

C. All erosion and sedimentation control measures and devices shall be constructed and installed as shown on the Drawings or specified herein and maintained until adequate permanent disturbed area stabilization has been provided or permanent pavement has been installed and accepted by the Engineer. After adequate permanent stabilization has been provided or permanent pavement has been installed and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

3.3 SEDIMENT CONTROL

A. Construction Exit:
   1. Construction exit(s) shall be placed as shown on the Drawings and as directed by the Engineer. A construction exit shall be located at any point traffic will be leaving a disturbed area to a public right-of-way, street, alley, sidewalk or parking area.
   2. Placement of Construction Exit Material: The ground surface upon which the construction exit material is to be placed shall be prepared to a smooth condition free from obstructions, depressions or debris. The plastic filter fabric shall be placed to provide a minimum number of overlaps and a minimum width of one foot of overlap at each joint. The stone shall be placed with its top elevation conforming to the surrounding roadway elevations. The stone shall be dropped no more than three feet during construction.
   3. Construction Exit Maintenance: The Contractor shall regularly maintain the exit with the top dressing of stone to prevent tracking or flow of soil onto public right-of-way and paved surfaces as directed by the Engineer.
   4. Construction Exit Removal: Construction exit(s) shall be removed and properly disposed of when the disturbed area has been properly stabilized, the tracking or flow of soil onto public right-of-way or paved surfaces has ceased and as directed by the Engineer.

B. Sediment Barriers:

1. Sediment barriers shall include, but are not necessarily limited to, silt fences, hay bales, rock check dams and inlet sediment traps and any device which prevents sediment from exiting the disturbed area.
2. Silt fences, hay bales and rock check dams shall not be used in any flowing stream, creek or river.
3. Sediment barriers shall be installed as shown on the Drawings and as directed by the Engineer.
4. Sediment barriers shall be maintained to ensure the depth of impounded sediment is no more than one half of the original height of the barrier or as directed by the Engineer. Torn, damaged, destroyed or washed out barriers shall be repaired, reinforced or replaced with new material and installed as shown on the Drawings and as directed by the Engineer.
5. Sediment Barrier Removal:
   a. Sediment barrier shall be removed once the disturbed area has been stabilized with a permanent vegetative cover or permanent pavement has been installed and the sediment barrier is no longer required as directed by the Engineer.
   b. Accumulated sediment shall be removed from the barrier and removed from the site.
   c. All non-biodegradable parts of the barrier shall be disposed of properly. The hay bales may be spread evenly across disturbed areas as a mulching material.
   d. The disturbed area created by barrier removal shall be permanently stabilized.

3.4 EROSION CONTROL

A. Grassing

1. Grassing shall be as specified in paragraph 3.5 of this Section
2. Temporary Stabilization: Temporary stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Temporary stabilization shall be provided to any area which will not receive permanent stabilization within the next 7 calendar days. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.
3. Permanent Stabilization:
   a. Permanent stabilization shall be provided as shown on the Drawings and conforming to these Specifications to control erosion on the site. Permanent stabilization shall be provided to all areas of land disturbance within seven

calendar days of the completion of land disturbance for any area greater than 0.25 acre. Partial payment requests may be withheld for those portions of the Project not complying with this requirement.

b. Grass or sod removed or damaged in residential areas shall be replanted with the same variety within seven calendar days of the completion of work in any area.

c. Where permanent stabilization cannot be immediately established because of an inappropriate season, the Contractor shall provide temporary stabilization. The Contractor shall return to the site at the appropriate season to provide permanent stabilization in areas that received only temporary stabilization.

B. Erosion Control Blanket:

1. Erosion control blankets shall be applied to sloped areas as indicated on the Drawings and where in excess of 2 to 1 slope. Blankets shall be laid on finished grades that have been seeded, insuring good contact with the soil. Soil surface shall be smooth and free of rocks, roots, debris and other obstructions.

2. Secure blankets with biodegradable staples or stakes at the top of slopes in a 6-inch deep x 6-inch wide anchoring trench. Secure blankets with staples or stakes per the manufacturer's recommendations, increasing the spacing at overlapping edges. Blankets shall be overlapped by a minimum of 8-inches. Provide a 6-inch deep x 6-inch wide anchoring trench at the toe of the slope or shoreline.

3.5 GRASSING

A. General:

1. Refer to Section 02933, Seeding and Sodding for detailed specifications on permanent seeding.

2. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition.

3. Specified permanent grassing shall be performed at the first appropriate season following establishment of final grading in each section of the site.

4. All references to grassing, unless noted otherwise, shall relate to establishing permanent vegetative cover as specified herein for seeding, fertilizing, mulching, etc.

5. Permanent grassing shall be of a perennial species.

B. Grassing activities shall comply with Section 02933, Seeding and Sodding, and the Manual for Erosion and Sediment Control in Georgia; specifically for the selection of species, planting dates and application rates for seeding, fertilizer and mulching. Where permanent vegetative cover (grassing) cannot be immediately established (due to season or other circumstances), the Contractor shall provide temporary vegetative or mulch cover.

3.6 RIP-RAP

A. Unless shown otherwise on the Drawings, rip-rap shall be placed at all points where banks of streams or drainage ditches are disturbed by excavation, or at all points where their natural vegetation is removed. Carefully compact backfill and place rip rap to prevent subsequent settlement and erosion. This requirement applies equally to construction alongside a stream or drainage ditch as well as crossing a stream or drainage ditch.

B. When trenching across a creek, place rip-rap a distance of 10 feet upstream and 10 feet downstream from the top of the trench excavation. Place rip rap across creek bottom, across creek banks and extend rip-rap placement five feet beyond the top of each creek bank.

C. Preparation of Foundations

1. The ground surface upon which the rip rap is to be placed shall be brought in close conformity to the correct lines and grades before placement is commenced. Where filling of depressions is required, the new material shall be compacted with hand or mechanical tampers.
2. Unless at creek banks or otherwise shown or specified, rip-rap shall begin in a toe ditch constructed in original ground around the toe of the fill or the cut slope. The toe ditch shall be two feet deep in original ground, and the side next to the fill or cut shall have that same slope. After the rip-rap is placed, the toe ditch shall be backfilled.

D. Placement of Filter Fabric

1. The surface to receive fabric shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. The fabric shall be placed with the long dimension running up the slope and shall be placed to provide a minimum number of overlaps. The strips shall be placed to provide a minimum width of one foot of overlap for each joint. The filter fabric shall be anchored in place with securing pins of the type recommended by the fabric manufacturer. Pins shall be placed on or within 3 inches of the centerline of the overlap. The fabric shall be placed so that

the upstream strip overlaps the downstream strip. The fabric shall be placed loosely so as to give and therefore avoid stretching and tearing during placement of the stones.

2. The fabric shall be protected at all times during construction from clogging due to clay, silts, chemicals or other contaminants. Any contaminated fabric or any fabric damaged during its installation or during placement of rip-rap shall be removed and replaced with uncontaminated and undamaged fabric at no expense to the City.

E. Placement of Rip-Rap

1. The rip-rap shall be placed on a 6 inch layer of soil, crushed stone or sand overlaying the filter fabric. This 6 inch layer shall be placed to maximize the contact between the soil beneath the filter fabric and the filter fabric. Rip-rap shall be placed with its top elevation conforming to the finished grades or the natural slope of the stream bank and stream bottom.
2. The stones shall be dropped no more than 3 feet during construction.
3. Stone rip-rap shall be dumped into place to form a uniform surface and to the thickness specified on the Drawings. The thickness tolerance for the course shall be -6 inches and +12 inches. If the Drawings do not specify a thickness, the course shall be placed to a thickness of not less than 18 inches.

3.7 CLEAN UP

Remove and dispose of all excess erosion and sedimentation control devices and materials when no longer needed or at the completion of construction as directed by the Engineer.

END OF SECTION

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SECTION 02140
DEWATERING

PART 1 - GENERAL

1.1 SCOPE:

A. Construct all permanent Work in areas free from water. Design, construct and maintain all dikes, levees, cofferdams and diversion and drainage channels as necessary to maintain the areas free from water and to protect the areas to be occupied by permanent work from water damage. Remove temporary works after they have served their purpose.

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.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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.

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 may be permitted to leave such temporary works in place. In such instances, breeching of dikes, levees and cofferdams may be required.

3.2 DEWATERING

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 ground water level no higher than 2 feet below the lowest point in the excavation.

C. Piezometric observation wells shall be required, to monitor the ground water 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. Dewatering water shall be disposed of in accordance with all Federal, State, and Municipal regulations at no additional cost to the City.

E. No separate payment will be made for dewatering required to accomplish the work.

F. Contractor shall provide Engineer with Dewatering Plan including disposal for Engineer's approval.

+++END OF SECTION+++

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 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 02575 - Removing and Replacing Pavement

1.2 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 City. 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 City.

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. Should the Owner choose to conduct its own testing, the Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all retests made necessary by the failure of materials supplied by the Contractor, his agents or subcontractors, to conform to the requirements of these Contract Documents shall be paid by the Contractor. 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.

1.3 SUBMITTALS

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

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.

1.4 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

2.1 MATERIALS

A. Earthwork Materials
1. Controlled Selected 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 a low to moderate plasticity, (PI<15) uniform composition, and be free of rock fragments greater

than two 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 except in cases with PVC or thermoplastic pipe in which case the maximum size shall be ¾ of an inch.

2. Structural Fill and Structural Backfill: Any structural fill used on site should be free of significant organic matter or debris, have a low to moderate plasticity (Plasticity Index < 20, Liquid Limit <50), exhibit relatively uniform composition, and be free of rock fragments greater than three inches in diameter. Soils selected for use as structural fill should have standard proctor (ASTM D698) maximum dry density of at least 90 pounds per cubic foot (pcf). Structural fill should be placed at a moisture content that corresponds to +/- 3 percent of the optimum moisture content, as determined by the standard proctor compaction test.

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 Construction of Transportation Systems, Section 800 for No. 57 Stone, Group II, and shall have the following gradation:

SIZE NO	NOMINAL SIZE SQUARE OPENING		AMOUNTS FINER THAN EACH LABORATORY SIEVE (SQUARE OPENINGS). %, BY WEIGHT										
	(1)	mm	2 ½"	2"	1 ½"	1"	¾"	½"	3/8"	No. 4	No. 8	No-16	No. 50
			63 mm	50 mm	37.5mm	25 mm	19 mm	12.5 mm	9.5 mm	4.75 mm	2.36mm	1.18 mm	300 µm
57	1-No. 4	25 – 4.75	-----	-----	100	95-100	-----	25-60	-----	00-10	00-5	-----	-----

(1) In inches, except where otherwise indicated. Numbered sieves are those of the United States Standard Sieve Series.

4. Top Soil: 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

3.1 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 City.

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 City unless otherwise indicated by the Engineer.

F. Extra Earth Excavation:

When 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 pipe lines 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. Refer to Section 02775 for replacement of damaged or removed 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. Piezometric observation wells shall be required to monitor the ground water 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 and shall be included in the plan.

6. The cost for all dewatering and discharge shall be at the Contractor's expense and shall be considered incidental.

3.2 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. With recommendation of the Testing Laboratory and approval by the Engineer, demolished, crushed concrete may be acceptable for use in fill areas.
   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 problems. 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.

3.3 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.

3.4 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.

3.5 TRENCH EXCAVATION

A. Trenches shall be excavated to the lines and grades shown on the drawings with the centerlines of the trenches on the centerlines of the pipes.

B. The sides of all trenches shall be vertical to a minimum of one foot above the top of the pipe. Unless otherwise indicated on the drawings, the trench width shall be equal to the sum of the outside diameter of the pipe plus 2 feet, within a tolerance of ± 3 inches. This distance will be measured at an elevation in trench which is 12 inches above the top of the pipe when laid to grade.

C. Wherever the prescribed maximum trench width is exceeded, the Contractor shall use the next higher class (load factor) of embedment or encasement for the full trench width as actually cut, at no additional cost to the Owner.

D. The trenches shall be excavated to the required depth allowing for the placement of pipe bedding to the thickness shown on the drawings.

E. Should the bottom of the trench become an unstable foundation for the pipe through the failure of the Contractor to adequately perform, the Contractor shall remove the unstable material and fill the trench to the proper subgrade with crushed rock. No extra compensation will be allowed for this material or work. Should the trench be inadvertently

excavated to a greater depth than necessary, crushed rock fill to the proper subgrade shall be provided at no additional cost to the Owner.

F. Should the undisturbed material encountered at the grade depth constitute, in the opinion of the Engineer, an unstable foundation for the pipe, the Contractor shall be required to remove such unstable material and fill the trench to the proper subgrade with crushed rock.

G. Control drainage in the vicinity of excavation so the ground surface is properly pitched to prevent water from running into the excavation.

3.6 BACKFILL AND FILL PLACEMENT

A. Compaction of fill shall be accomplished by placing the fill material in horizontal lifts of eight-inches (8") 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 +/- 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 ensure 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 the density of backfill, 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:
All areas where pavement or structures are to be built on compacted fill (and other areas indicated on the Drawings), shall be proofrolled to detect soft spots prior to the placement of fill material or construction of foundations.
1. 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.
2. 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 ensure 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.

3. 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.
4. 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.
5. 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. Wet silty soils shall require aeration prior to compaction even during dry periods.

3.7 BACKFILLING AROUND STRUCTURES

General:

A. Remove debris from excavations before backfilling.

B. Do not backfill against foundation walls until so instructed by the Engineer

C. Wherever possible, backfilling shall be simultaneous on both sides of walls to equalize lateral pressures.

D. 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.

3.8 BACKFILLING TRENCHES

A. The backfilling of sewer, water, storm, and other pipe line trenches shall be started immediately after the construction of same has been inspected by the Engineer. Selected backfill material shall consist of finely divided earth, stone dust, sand, crushed stone, or other approved material free from all wood, vegetative matter, debris and other objectional material and having scattered clods, stone or broken concrete less than 2 inches in maximum dimension.

B. Backfill material shall be carefully placed in the trench on each side of the pipe in 6-inch layers for the full width of the trench and thoroughly and uniformly compacted by tamping or ramming as detailed in the construction plans.

C. Backfilling shall be carried on simultaneously on both sides of the pipe and in a manner which will prevent injurious side pressures. If suitable select materials are not available from the trench excavation, the Contractor will be required to obtain the select material elsewhere.

D. Across sidewalks and driveways and at any other places subject to vehicular traffic or other superimposed loads, trench backfill shall be compacted in 6 inch layers to the density of the original adjacent material for the full depth of the trench. The top 6 inches of backfill shall consist of uniformly graded crushed stone.

E. Trenches under concrete slabs and footings of structures shall be filled with dry sand or crushed stone and tamped in 6 inch layers. Piping under concrete slabs and footings shall be encased (6 inches minimum) in concrete.

3.9 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.

3.10 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 ensure dry excavations, preserve final lines and grades, and 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.

3.11 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 City.

B. The Contractor shall make, or will be caused to make, all repairs or replacements made necessary by settlement within thirty (30) days after receipt of written notice from the Engineer.

3.12 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 +++

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SECTION 02370
AUGER CAST GROUT PILES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish, install and test auger cast grout piles. Included are the following:
2. Extent of auger cast grout piles is as shown and as directed by the ENGINEER, in writing.

B. Pile Capacity:
1. At locations specified and shown:
Provide and install 75 ton compression capacity (allowable capacity) drilled pile foundations.
2. Piles consist of drilled 12-inch piles designed as a steel reinforcement surrounded by a cement grout.

C. Coordination:
Review installation procedures under other Sections and coordinate the installation of piles.

D. Related Sections:
1. Section 03200, Concrete Reinforcement & Doweling.
2. Section 03300, Cast-In-Place Concrete.

1.2 REFERENCES
Standards referenced in this Section are listed below:

A. American Concrete Institute, (ACI).
1. ACI 305, Hot Weather Concreting.
2. ACI 306, Cold Weather Concreting.

B. American Society for Testing and Materials, (ASTM).
1. ASTM A 615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
2. ASTM C 33, Specification for Concrete Aggregates.
3. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens).
4. ASTM C 150, Specification for Portland Cement.

5. ASTM C 192, Practice for Making and Curing Concrete Test Specimens in the Laboratory.
6. ASTM C 618, Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
7. ASTM C 939, Test Method for Flow of Grout for Preplaced-Aggregate Concrete.
8. ASTM D 1143, Test Method for Piles Under Static Axial Compressive Load.
9. ASTM D 1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils.
10. ASTM D 3689, Test Method for Individual Piles Under Static Axial Tensile Load.

1.3 QUALITY ASSURANCE

Concrete Testing Service:

A. CONTRACTOR shall employ, at his own expense, a testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
   1. Testing agency shall meet the requirements of ASTM E 329.
   2. Selection of a testing laboratory is subject to ENGINEER'S approval.
   3. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities, equipment, and other information, which may be requested by ENGINEER.

B. Materials and installed Work may require testing and retesting, as directed by ENGINEER, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at OWNER'S expense, including the retesting of rejected materials and installed Work, shall be done at CONTRACTOR'S expense.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   Shop Drawings:
   1. Full data on type of pile proposed and on equipment to be utilized.
   2. Description and sketch or catalog data of the pile installation rig including leads, auger, grout pump and auger motor.
   3. Proposed pile installation sequence referenced to the pile plan as shown.

4. Proposed pile installation procedures.
5. Pile numbering plan.
6. Complete data on pile load test equipment instrumentation, load equipment calibration, load application and protection, if any.
7. Proportioning of grout and installation of auger cast grout piles shall be performed in accordance with the provisions of these Specifications. Provide a description of the materials to be used and the proposed method of operations, and furnish records and data to demonstrate that the finished piles will meet, in all respects, the quality and properties required by these Specifications.

B. Informational Submittals: Submit the following:
1. Source Quality Control Submittals:
Grout Mix Design and Test Reports: Ten days prior to start of the Work, the proposed grout mix design, flow cone and strength test results on samples of grout demonstrating conformance to contract requirements.
2. Site Quality Control Submittals:
Submit each test report for load test within two days after completion of tests.
3. Qualification Statements:
Qualifications of personnel supervising the performance of pile installation.

C. Closeout Submittals: Submit the following:
Record Documentation:
1. Submit the installation record of each pile to ENGINEER not later than two days after installation is completed. Include the Project name and number, name of Contractor, name of Installer, pile location and number, computed pile capacity, rate of operation of pile installation equipment, pile dimensions, tip elevation, elevation of butt, ground elevation, pile deviation, quantity of grout placed and any unusual occurrences during pile installation.
2. Submit Record Drawings showing exact location of each pile as installed.

1.5 DELIVERY, STORAGE AND HANDLING

A. Except for piles to be used for test purposes, materials ordered or delivered to the Site prior to verification of the assumed pile length, will be at CONTRACTOR'S risk.

B. After pile lengths are verified, deliver materials to the Site in such quantities and at such times to assure the continuity of pile driving operations to the Project Schedule.

C. Store piles in orderly groups above ground and blocked during storage to minimize possible distortion.

D. Supplier of grout shall be located in close proximity to the Project and not more than 30 minutes driving time away.

1.6 JOB CONDITIONS

A. Site Information:

Additional test borings and other exploratory operations may be made by CONTRACTOR at no additional cost to OWNER, provided such operations are acceptable to ENGINEER, in accordance with contract documents.

B. Line and Level:

ENGINEER or OWNER will establish a benchmark on the Site and a baseline for the use of CONTRACTOR in establishing lines and levels for the Work. CONTRACTOR shall establish and locate all other lines and levels and be responsible for the correct location and deviation measurements of all piles.

C. Protection:

1. Protect structures, underground utilities and other construction from damage caused by pile installation operations.
2. When structures are adjacent to pile installation operations, provide surveyed elevation benchmarks on structures where directed by ENGINEER before commencing Work. Record and report the elevation of each benchmark at least twice a day while pile installation is in progress. Should benchmark readings indicate any displacement, halt operations and provide corrective action acceptable to ENGINEER.

D. Cost of ENGINEER'S Redesign:

1. Piling driven incorrectly, out of position, or which is defective in any way shall be corrected as directed by ENGINEER and as described hereinafter.
2. ENGINEER will record all time required by him and their consultants, if any, in redesigning piling, foundations or other related structural work and in making revisions to the Contract Documents.

3. CONTRACTOR shall reimburse OWNER for the additional services of the ENGINEER and their consultants based on a charge of 2.5 times salary costs.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete shall conform to the requirements of Section 03 30 00, Cast-In-Place Concrete, except coarse aggregate shall be as specified herein.
   1. Portland cement shall conform to the requirements of ASTM C 150.
   2. Pozzolan shall, if used, conform to the requirements of ASTM C 618, Class F.
   3. If CONTRACTOR elects to use a mortar fluidifier, he shall submit manufacturer's data on the use of this product to ENGINEER for review and approval.
   4. Water shall be fresh, clean, and free from injurious amounts of sewage, oil, acid, alkali, salts, or inorganic matter.
   5. Other admixtures shall not be used.
   6. Fine aggregate shall meet the requirements of current ASTM C 33 standards, except that grading may be modified if compressive strength requirements are satisfied.

B. Reinforcing Bars shall have a minimum yield of 60,000 psi and shall conform to the requirements of Section 03200, Concrete Reinforcement & Doweling. If tension piles require high strength steel tendons, the tendons shall be deformed and have a minimum ultimate tensile capacity of 150,000 pounds per square inch. Deformations shall conform to the requirements as described in ASTM A 615. Tendon shall be placed for the full length of the pile.

C. Grout Mix for Auger Drilled and Grouted Piles:
   1. Grout shall consist of a mixture of Portland cement, sand and water proportioned and mixed to provide grout capable of maintaining solids in suspension without appreciable water gain, but placed without difficulty, and laterally penetrate and fill voids in the foundation material. Materials shall be proportioned to attain a minimum 28 day compressive strength of 4,000 psi.
   2. Grout mix shall be tested in accordance with the requirements of ASTM C 109 and ASTM C 192 for each day during which piles are placed. All samples will be taken at the mid-point of installation of a pile.

3. Only approved pumping, continuous mixing and agitating equipment shall be used in the preparation and handling of the mortar. Oil or other rust inhibitors shall be removed from mixing drums and grout pumps. Materials shall be such as to produce homogeneous grout of the desired consistency.
4. Grout pump shall be a positive displacement piston type pump capable of developing displacing pressures at the pump up to 350 psi. Minimum volume of grout pumped for each hole shall be at least equal to 125 percent of the volume of the augered hole.

2.2 EQUIPMENT FOR INSTALLING PILES

Equipment for Installing Auger Drilled and Grouted Piles:

A. Hole through which the high-strength grout is pumped during the placement of the pile, shall be located at the bottom of the auger head, below the bar containing the cutting teeth.

B. Auger flighting shall be continuous from the auger head to the top of auger, with no gaps or other breaks. Pitch of the auger flighting shall not exceed nine inches.

C. Augers over 40-feet in length shall contain a middle guide.

D. Piling leads should be prevented from rotating by a stabilizing arm.

E. Piling leads for auger flights shall be clearly marked in five feet increments on all sides of lead tower. Numerals shall be of adequate size such that they are readable from a distance of 40-feet.

PART 3 - EXECUTION

3.1 INSPECTION

CONTRACTOR shall examine the areas and conditions under which augered grout-injected piles are to be installed. Notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the ENGINEER.

3.2 PRE-INSTALLATION WORK

Site Conditions:

Do not install piles until earthwork in area, which piles are to occupy, has been completed, as follows:

A. Excavations: Earth excavation shall be complete before piles are installed. Remove excess spoils from excavated area.

B. Fills: Construct and compact fills to the elevation of the grade shown. Remove excess spoils from fill area.

3.3 GENERAL REQUIREMENTS

A. Piles shall be installed with due consideration for the safety of adjacent structures and existing active utilities by a method, which leaves their strength unimpaired, and which develops and retains the required load bearing capacity.

B. Augered grout-injected piles shall be made by rotating a 12-inch diameter continuous-flight hollow-shaft auger into the ground to a tip elevation as shown on the Contract Drawings or as directed by ENGINEER. Grout shall then be injected through the auger shaft as the auger is being withdrawn in such a way as to exert removing pressure on the earth filled auger as it is being withdrawn as well as lateral pressure on the soil surrounding the mortar filled pile hole. Reinforcing shall be placed prior to grout injection.

C. Each pile shall contain reinforcing bars as shown on the Contract Drawings for compression pile conforming to Section 03200, Concrete Reinforcement, placed through the hollow shaft auger which shall act as the centralizer to assure minimum grout cover. The bar shall extend the full length of the pile in all piles. Piles with bars of insufficient length shall be rejected.

D. CONTRACTOR shall submit a schedule for pile installation. Piles shall not be installed until the schedule is accepted by the ENGINEER. Piles closest to existing structures shall be installed and tested first followed by piles progressively further away.

3.4 PILE INSTALLATION

A. General:
   1. Installation shall be performed in an orderly sequence progressing in one direction across each foundation element.
   2. Continuously install each pile at the locations indicated, to the elevation determined for each pile by the ENGINEER.
   3. Carefully plumb the leads and the auger before installation.
   4. When installing piles within 20 feet of existing structures, the weight of the augers and auger head shall be at least 7.0 kips to increase the

rate of auger penetration. Auger rotation shall stop immediately, after reaching maximum depth and shall not start again until grouting has begun.

5. In the event that nonaugerable material is encountered such as cobbles, boulders, rock ledge, metal, timbers, or debris which causes the rate of penetration to be reduced to less than one foot per minute or causes the pile to drift from its location, the pile shall be completed to the depth of the nonaugerable material in accordance with these Specifications. The length of such short piles shall be included in the total linear feet of pile for payment. If required by the ENGINEER, one or more additional adjacent piles shall be placed and the length of these additional piles shall also be included in the total linear feet of piles for payment. Piles mistakenly placed by CONTRACTOR will not be paid for.

B. Installation:

1. Grout shall be pumped as soon as practicable after mixing, and in no case shall grout be used which does not reach its final position in the pile within 1-1/2 hours after truck mixed grout leaves the plant as evidenced by the delivery ticket provided to the inspector.
2. Only approved mixing and pumping equipment shall be used in the preparation and handling of grout. A screen to remove oversize particles shall be placed at the pump inlet. All soil or other rust inhibitors shall be removed from the mixing drums, stirring mechanisms, and other portions of the equipment in contact with the grout before the mixers are used.
3. All materials shall be accurately measured by volume or weight as they are fed into the mixer. Time of mixing shall be not less than one minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding two hours at grout temperatures below 70°F and for a period not exceeding 1-1/2 hours at higher temperatures. When a set retarding admixture is used, the grout may be held for a period of two hours at temperatures below 90°F. Grout shall not be placed when its temperature exceeds 90°F.
4. Accurate records shall be maintained showing the depth to which piles are placed and the quantity of grout placed. Any unusual conditions encountered during pile installation shall be noted. The leads of the rig shall be clearly marked in one-foot increments.
5. Piles installed the same day shall not be closer than nine feet center to center of each other.

6. The hole in the bottom of the auger shall be plugged while being advanced into the ground. The plug shall be fabricated from steel tubing to fit snuggly into the hole. Plug shall be removed by grout pressure or with the reinforcing bar.
7. Grout shall be pumped with initial pressure of approximately 250 psi at the pump as the auger is withdrawn allowing the mortar to fill the hole, preventing its collapse, and permitting lateral intrusion of the mortar into the surrounding soil. A second pressure gage shall be provided located as close to the auger rig as possible such that it is just touching the ground when the auger is in the raised position. The range of this gage shall not exceed twice the normal pumping pressure.
8. Grout pump shall be provided with a calibrated pressure gage in clear view of the equipment operator. A digital counter shall be used to measure the number of grout pump strokes during installation. Grout pump shall be calibrated at the beginning of the Work to determine the number of pump strokes to fill a 55-gallon drum with mortar. Pump shall be recalibrated following repair or switching pumps or at least once at the request of ENGINEER during pile installation. CONTRACTOR shall have on hand a spare counter and a spare pump. Spare pump shall be utilized when the primary pump is not functioning properly and when directed by ENGINEER.
9. Positive rotation of the auger shall be maintained throughout placement of the grout. Rate of grout injection and rate of auger withdrawal from the soil shall be so coordinated as to maintain at all times a positive pressure on these gages, which will, in turn, indicate the existence of a removing pressure on the bottom of the auger flight in conformance with Article 3.3, above. Total volume of grout shall be at least 15 percent greater than the theoretical volume for each five-foot segment of pile, except after grout is flowing at the ground surface from the auger blade, a minimum of five cubic feet per five-foot segment shall be pumped. However, the total volume of grout pumped shall be at least 25 percent greater than the theoretical volume of the pile. If pumping of grout is interrupted for any reason or if a return at the surface is noted, CONTRACTOR shall reinsert the auger at least five feet into the pile and regrout.
10. If less grout is placed than the net volume required for any five-foot increment, the piles shall be reinstalled by rotating the auger to the bottom of the pile followed by controlled removal and mortar injection.

11. A head of at least ten feet of grout above the injection point shall be maintained around the perimeter of the auger flights during raising of the auger so that the grout has a displacing action, removing any loose material from the hole. This head shall be initially established by raising the auger 6- inches from the bottom while rotating, pumping grout until a sufficient quantity is measured, lowering the auger to its original level and finally starting the removal process.
12. Auger hoisting equipment shall be so designed as to enable the auger to be withdrawn smoothly and steadily. Augers in excess of 40 feet in length shall be provided with a traveling guide.
13. Magnitude of removing pressure and performance of other augering and grouting operations such as the rate of augering, rate of grout injection, and control of grout return around the auger flight are dependent on soil conditions and equipment capability and shall be entirely the responsibility of CONTRACTOR.
14. The spoil and excess grout that accumulates around the auger during injection of the grout shall be continuously cleared away so that the installation can be properly inspected. Excess grout and spoil shall be removed from the Work area at the end of each day. Do not use back-hoe or equivalent equipment adjacent to freshly placed piles within a 48-hour period to avoid possible damage to reinforcement and piling.
15. Provide protective cover for each pile after installation.
16. Test each truckload of grout using the Flow Cone Test ASTM C 939, except a 3/4-inch opening is used rather than the 1/2-inch opening specified. Maintain grout fluidity of between 15 and 25 seconds.
17. Should water or ponding collect at the top of a freshly grouted pile, the water shall be removed immediately by bailing-out and replaced with fresh grout.
18. A 1-1/4-inch outside diameter flush joint casing capped at both ends and filled with oil shall be substitute for the 1.128-inches diameter reinforcing bar in one of the test compression piles to permit telltale installation.
19. Reinforcing cages for pile extensions shall be installed as shown.

C. Installation Tolerances:
Install piles within the following maximum tolerances:
1. Location: 3-inches from the location indicated for the center of gravity of each single pile or pile groups.
2. Plumbness: Maintain 2-inches in ten feet from the vertical.

D. Corrective Action:

1. ENGINEER may survey the piles at any time. If any discrepancy is detected, CONTRACTOR shall replace the pile or piles, at no additional cost to the OWNER.
2. As soon as possible, after completion of installation of piles, CONTRACTOR shall prepare an accurate survey made by a licensed surveyor and furnish ENGINEER with a record showing the final position of the top of each pile and location of unacceptable piles.
3. ENGINEER will check the piling and determine its acceptability. If not acceptable, the ENGINEER will advise CONTRACTOR what additional piles must be furnished or other corrective measures to be taken.
4. ENGINEER will provide redesign, as required, because of piles installed out of location. All corrective measures, including cost of ENGINEER'S redesign, shall be at CONTRACTOR'S expense.
5. Partial surveys of piles at cutoff elevation may be submitted, as driving proceeds, in order to expedite the Work.

E. Jetting:
Jetting shall not be employed.

F. Damaged Piles or Piles Out of Tolerance:
1. Damaged piles, and piles installed outside the required installation tolerances, will not be accepted.
2. Cut-off and abandon piles rejected after installation, and replace with new piles.
3. Install additional piles where the centerline deviation exceeds 3-inches and a redesign indicates a load on any pile exceeding 110 percent of the design load. Where these additional piles necessitate changes in pile cap dimensions or reinforcement, CONTRACTOR shall carry out all corrective measures required to obtain the approval of ENGINEER, at no additional cost to the OWNER. Should it be impractical to install additional piles in particular situations, provide reinforced concrete straps or other measures as directed by ENGINEER for redistributing the design loading, at no additional cost to the OWNER.

G. Cutting-Off:
Cut-off the tops of piles, square with pile axis and at the elevations indicated by removing fresh mortar from the top of the pile or by cutting off hardened mortar down to final cut-off point at any time after initial set has occurred.

H. Cold Weather Placing:

Protect mortar work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in conformance with the requirements of ACI 306.

I. Hot Weather Placing:
When hot weather conditions exist that would seriously impair the quality and strength of mortar, place mortar in, in conformance with the requirements of ACI 305.

3.5 FIELD QUALITY CONTROL

A. Install and load test piles in order to confirm or modify design pile lengths. Pile load test shall be performed in accordance with ASTM D 1143 or ASTM D 3689, and as modified herein. Provide complete testing materials and equipment as required, and perform test only in the presence of ENGINEER. Test piles shall be installed and loaded from the excavation subgrade level.

B. Test piles furnished and installed by CONTRACTOR to determine lengths of piles, may be located, cut off, and become part of the foundation system provided the pile conforms to these Specifications requirements.

C. Pile Design Load:
1. The required safe working capacity for piles shall be 75 tons downward.
2. Tension piles not required.

D. Preparation of Grout Test Specimens:
Throughout each eight-hour shift, at least six test specimens of grout shall be prepared by pouring grout, taken from the auger discharge, into 2-inch by 2-inch by 2-inch cube molds and tested in accordance with ASTM C 1017.

END OF SECTION

SECTION 02510
ASPHALT PAVING

PART 1 - GENERAL

1.1 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.

1.2 SUBMITTALS

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

A. Batch design.

B. Density and viscosity tests on each run.

C. Weight slips for pavement base and asphalt paving materials.

1.3 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 chat the required tonnage has been applied.

1.4 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 City.

PART 2 - PRODUCTS

2.1 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 Engineer, 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

3.1 EXCAVATING. FILLING AND GRADING

Perform excavating and filling in accordance with Section 02200 entitled "Earthwork" of these Specifications.

3.2 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 on the Drawings.

3.3 CLEANING

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

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SECTION 02521

CONCRETE SIDEWALKS, CURBS, AND GUTTERS

PART 1 - GENERAL

1.1 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 02200, Earthwork.
2. Section 03200, Concrete Reinforcement and Doweling.
3. Section 03300, Cast-In-Place Concrete.

1.2 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 approval of the Engineer at no additional cost to the City.

1.3 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 CONCRETE REINFORCEMENT

Concrete reinforcement shall conform to Section 03200, Concrete Reinforcement and Dowelling.

2.2 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 shall be Class G 3,000 psi and conform to requirements of Section 03300.

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.

E. Sub-base shall be constructed of durable material such as bank-run gravel. Minimum depth of sub-base shall be 3-inches.

F. 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

3.1 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.

3.2 SUBGRADE PREPARATION

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 98% of dry density per ASTM 698 and finished to a smooth and unyielding surface. 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.

3.3 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 ¼-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 City.

3.4 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:

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 City.

3.5 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.

3.6 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. Contractor 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 02933, Seeding and Sodding.

END OF SECTION

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SECTION 02535
GRAVITY FLOW SANITARY SEWERS

PART 1 - GENERAL

1.1 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 01200 - Measurement and Payment
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 and Storm Sewers
7. Section 02735 – Sewer Service Connections
8. Section 03300 - Cast-In-Place Concrete

1.2 SUBMITTALS

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

A. 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.

B. The Contractor shall submit manufacturers' instructions indicating special procedures required to install products specified.

C. The Contractor shall submit certifications that products meet or exceed the requirements specified in these Specifications.

D. The Contractor shall submit a set of plans (modified to show as-built conditions.)

E. The Contractor shall submit test reports.

1.3 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/ft3 (600 kN-m/m3)).

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/ft3 (2,700 kN-m/m3)

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. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications. The Engineer shall have the right to witness testing of the materials, provided that the Contractor's schedule is not delayed for the convenience of the Engineer.

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. If directed by the Engineer, each pipe manufacturer shall furnish the services of a competent factory representative to supervise and/or inspect the installation of pipe. This service will be furnished for a minimum of five (5) days during initial pipe installation.

G. All pipes shall be subject to inspection by the Engineer at the place of manufacture. The Contractor shall notify the Engineer in writing of the manufacturing start date at least fourteen (14) days prior to the start of manufacturing. The Contractor shall be responsible for all inspection costs.

H. All pipes shall be inspected upon arrival. If any portion of a shipment is found to be defective in diameter or thickness, the entire shipment shall be rejected and removed from the site of the Work at no cost to the City. Each section of pipe shall again be thoroughly inspected immediately prior to lowering it into the trench to insure that the interior is clean and to check for joint scratches, chipped ends, and imperfect gasket seats. Any defective pipe or fitting discovered after the pipe is laid shall be removed and replaced with a satisfactory pipe or fitting without additional charge.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

2.1 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.

2.2 TRANSITION COUPLINGS

Transition joints between sewer pipes of different materials shall be accomplished by the use of City of Atlanta standard concrete collar walls. Use of any other material shall require approval by the Engineer.

2.3 APPURTENANCES

A. Service connections shall conform to the requirements of Section 02735 - Sewer Service Connections.

B. Manholes shall conform to the requirements of Section 02641 - Precast Concrete Manholes.

2.4 BACKFILL

Pipe backfill materials shall conform to the requirements of Section 02200, Earthwork.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall control traffic in accordance with the requirements of Section 01550 - Traffic Regulation.

B. 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.

C. 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.

D. 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.

E. The Contractor shall install and operate a dewatering system in accordance with the requirements of Section 02140 - Dewatering.

F. Where wastewater flow diversion is required for the performance of the Work, the Contractor shall provide wastewater flow diversion in accordance with the requirements of Section 02600 - Wastewater Flow Control.

3.2 PIPE LAYING

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 anytime more trench than his available pumping facilities are able to dewater. Movement of water that would tend to erode or affect the trench walls will not be allowed.

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.

3.3 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 mechanical joints, except where grooved 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 anytime after completion of the Work shall be repaired immediately. Testing of gravity sewers shall be performed in accordance with the requirements of Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers. All pipe in place shall be carefully protected from damage until the backfilling operations have been completed. Any pipe which has been disturbed after jointing shall be removed, the joint cleaned and remade and the pipe relaid at the Contractor's expense.

3.4 TEE CONNECTIONS

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.

3.5 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 02200 - Earthwork, and compacted to the equivalent density of the surrounding undisturbed material.

3.6 SERVICE SEWERS

A. Stubouts for s service lines shall be installed when stipulated in the Special Conditions or shown on the Plans. However, additional connections shall be installed by the Contractor when directed by the Engineer.

B. Cleanouts shall be installed for each continuous run of one hundred (100) feet and at each change in horizontal or vertical direction. Cleanouts shall be constructed in accordance with the Detail Drawings. Cleanouts shall be plugged with approved stoppers. Stoppers shall be properly restrained.

C. Backfilling for service lines shall commence immediately upon acceptance by the Engineer. Backfill materials shall be as specified in Section 02315 - Excavation and Backfill for Structures, and shall be compacted to the equivalent density of the surrounding undisturbed material.

3.7 CONNECTING EXISTING SANITARY SEWERS TO NEW SANITARY SEWERS

A. All existing separate sanitary sewers shall be connected to new separate sanitary sewers as shown on the Plans or as directed by the Engineer. Connections shall be made by the construction of a manhole or utilization of an existing manhole.

B. Connection of lateral collector sewers to large diameter trunk sewers shall be made at existing manholes or new manholes.

C. Connections to existing manholes shall be made by coring a hole in the wall of the existing manhole, installing a boot, inserting the same pipe material as the mainline being constructed, filling around same with non-shrinking grout and troweling the inside and outside surfaces of the joint to a neat finish.

D. Connections of existing separate sanitary sewers to new separate sanitary sewers shall be plugged, and shall remain plugged until final acceptance by the Engineer.

3.8 TOLERANCES

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:

A. If the sewer is laid at negative grade, the Contractor shall remove and reinstall the sewer at the correct grade at no additional cost to the City.

B. If the sewer is laid at a grade less than that shown on the Plans, thus reducing the sewer's capacity, the City may require the sewer to be removed and relaid at the correct grade at no additional cost to the City. As a minimum, the grade to the next upstream manhole shall be adjusted such that the next upstream manhole shall be set at the correct elevation.

C. If the sewer is laid at a grade greater than that shown on the City, and if the Contractor can show that there are no conflicts with upstream existing utilities or obstructions, the Contractor shall adjust the grade of the next upstream manhole such that the next upstream manhole shall be set at the correct elevation. If such an adjustment, in the Engineer's opinion, is substantial, the grade adjustment shall be spread over multiple sections of the sewer. If such an adjustment, in the City's opinion, significantly reduces the sewer's capacity, the City may require the Contractor to remove and relay that portion of the sewer laid at the improper grade.

3.9 PIPE PROTECTION

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.

3.10 TESTING

All manholes shall be vacuum tested and all gravity flow sanitary sewer joints shall be pressure tested in accordance with the requirements of section 2650, Testing for Acceptance of Sanitary and Storm Sewer. Testing shall be performed in the presence of the Engineer.

3.11 CLEANUP

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. 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.

B. 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.

C. 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.

D. All manhole covers shall be brought to grade, as shown on the Plans, or as directed by the Engineer.

END OF SECTION

SECTION 02537
DUCTILE IRON SANITARY SEWER PIPE AND FITTINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes Specifications for ductile iron sanitary sewer pipe and fittings for sanitary sewer installations as shown on the Plans and as specified in these Specifications.

B. The Contractor shall provide all services, labor, materials, and equipment for all installation of ductile iron sanitary sewer pipe and fittings and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere:

1. Section 01200 - Measurement and Payment
2. Section 02200 - Earthwork
3. Section 02140 - Dewatering
4. Section 02535 - Gravity Flow Sanitary Sewers
5. Section 02600 - Wastewater Flow Control
6. Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers
7. Section 02735 – Sewer Service Connections

1.2 SUBMITTALS

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

A. The Contractor shall submit, for the Engineer's approval, descriptive details and shop drawings covering full details of pipe, fittings, joints and the assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.

B. The Contractor shall provide manufacturers' certifications that all ductile iron pipe and fittings meet the provisions of this section and meet the requirements of ANSI A21.51 (AWWA C151). Product certification shall include tensile and Charpy test results which shall be traceable to pipe numbers and testing periods. For pipe sizes thirty (30) inches and larger, hydrostatic test charts including pipe numbers for each test cycle shall be furnished as part of the certification test reports. Chemical analysis shall

be furnished for each ladle of iron which will cover each pipe cast and must correlate with the mechanical test results. For pipe sizes thirty (30) inches and larger, complete traceability is required throughout the certification process and must be clearly legible on each pipe at the point of installation. Hydrostatic test results for any size pipe shall be furnished to the Engineer.

C. The Contractor shall provide certifications that all pipe joints have been tested and meet the requirements of ANSI A21.11 (AWWA C151).

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

A. ANSI A21.4 (AWWA C104) - Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, for Water and Other Liquids.

B. ANSI A21.10 (AWWA C110) - Ductile Iron and Gray Iron Fittings, 3-in. through 48-in., for Water and Other Liquids.

C. ANSI A21.11 (AWWA C111) - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.

D. ANSI A21.15 (AWWA C115) - Flanged Ductile Iron Pipe with Threaded Flanges.

E. ANSI A21.50 (AWWA C150) - Thickness Design of Ductile Iron Pipe.

F. ANSI A21.51 (AWWA C151) - Ductile Iron Pipe, Centrifugally Cast for Water and Other Liquids.

G. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

H. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.

I. ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials.

J. ASTM G62 - Test Methods for Holiday Detection in Pipeline Coatings.

K. AWWA C600 - Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.

L. SSPC-SP6 - Steel Structures Painting Council, Commercial Blast.

M. The Contractor shall submit certification from the manufacturer, sealed and stamped by a Professional Engineer Registered in the State of Georgia who is not an employee of the manufacturer, that the pipe to be supplied under this Agreement will provide a one-hundred (100) year service life if manufactured and installed in accordance with the plans and specifications for this project.

1.4 MATERIAL TESTING

A. The attention of the Contractor is directed to the provisions of the Conditions of the Contract requiring the inspection and testing of materials to be incorporated into the Work.

B. Each pipe in the size range four (4) inches to twenty-four (24) inches shall receive a hydrostatic proof test of 500 psi for a minimum duration of fifteen (15) seconds. Each pipe in the size range thirty (30) inches and larger shall receive a hydrostatic test not less than seventy-five (75) percent of the specified minimum yield strength for the duration of the test. Each test cycle shall be recorded on a strip chart. Each test cycle for pipe thirty (30) inches and larger shall be marked by pipe number. Each pipe shall be inspected for leaks. Pipes which contain evidence of hydrostatic leak shall be scrapped. Repair welding of hydro-leaks is not permitted.

C. Tensile test specimens shall be cut longitudinally from the midsection of the pipe wall. These specimens shall be machined and tested at least every three (3) hours in accordance with the requirements of ASTM E8, and ASTM A370 where applicable, using the 0.2% offset method. Brinell hardness tests shall be performed at the same frequency as the tensile test and shall meet a maximum Brinell hardness of two-hundred and thirty (230). Pipe failing to meet the minimum requirements of these standards shall be rejected. Adjacent test samples shall be made available to the City's independent testing laboratory upon the City’s request.

D. Charpy impact samples shall be taken during each hour of production. Samples shall be selected to properly represent extremes of pipe diameters and wall thickness. Impact tests shall be conducted in accordance with the requirements of ASTM E23. Impact strengths on samples shall be eight (8) ft-lb minimum for tests conducted at seventy 70° ± 10 per ANSI A21.51 (AWWA C151). In addition, adjacent specimens shall be taken and made available to the City's laboratory for independent testing upon the City's request.

E. Each end of each pipe (each pipe socket and pipe spigot) shall be measured and shall conform to the standard dimensions of ANSI A21.51 (AWWA C151). In addition, each socket and spigot shall be inspected in a well lighted area for injurious defects which could affect joint performance. Such defects may be removed by cutting off pipe ends. Pipe with injurious defects in the bell must be scrapped.

F. The City or the City's designated inspection agency shall have access to all areas of the pipe manufacturer's plant during production, inspection, and shipping and shall have the opportunity to witness all tests associated with production and inspection of pipe and fittings for any given order. Reasonable facilities shall be provided for the City or the City's designated inspection agency to facilitate their work while at the manufacturing facility. All production and quality assurance records shall be made available for review by the City or the City's designated inspection agency upon request.

G. All testing work specified in this section shall be performed by the supplier. The manufacturer shall perform all tests in house as part of their quality assurance/quality control. Test results shall be submitted to the Engineer in accordance with the requirements of this section.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE

A. Ductile iron pipe shall be centrifugally cast, manufactured, and tested in accordance with the requirements of ASTM A746 and furnished in minimum eighteen (18) feet to twenty (20) feet lengths unless otherwise approved by the Engineer. Pipe class shall be Class 50 unless otherwise specified on the plans.

B. Joints for ductile iron pipe shall be mechanical joints unless specified elsewhere in these Specifications or approved by the Engineer. Joints shall be manufactured in accordance with the requirements of ANSI A21.11 (AWWA C111).

C. For ball and socket joints, the bell, ball, and retainer shall be ductile iron, Grade 70-50-05, conforming to the requirements of ANSI A21.11 (AWWA C111).

D. Joints for flanged pipe shall conform to the requirements of ANSI A21.11 (AWWA C111).

E. Restrained joints shall conform to the requirements of ANSI A21.10 (AWWA C110) unless otherwise approved by the Engineer.

F. Joints for “bell less” ductile iron MT Push Pipe or GS Push Pipe shall be sealed with O-ring rubber gaskets installed in an independent internal coupling or in a machined tongue and groove type joint. Joint shall be manufactured in accordance with the requirements of ANSI A21.11 (AWWA C111) and supplied in minimum four (4) foot lengths unless otherwise approved by the Engineer.

G. Ductile iron pipe shown on the drawings or otherwise specified of another class other than class 50 shall be marked by the manufacturer for ease of identification. Class 51 shall have 2 - 2inch yellow stripes, Class 53 shall have 3 - 2inch yellow stripes, etc.

2.2 FITTINGS

A. The Contractor shall use fittings of the same size and pressure rating as the pipe.

B. Unless otherwise specified elsewhere in these Specifications or approved by the Engineer, mechanical joint fittings shall be used for both push-on type and mechanical joint type pipe. Ductile iron fittings for push-on pipe shall be designed for the same working pressure, laying conditions, and cover as the pipe which is used.

C. Fittings manufactured for ductile iron pipe shall conform to the requirements of ANSI A21.10 (AWWA C110), unless not made in C110, and C153 will be approved.

2.3 COATINGS

All ductile iron pipe and fittings used in open cut installations shall have a double cement-mortar lining conforming to the requirements of ANSI A21.4 (AWWA C104) and a standard bituminous outer coating. In four (4) inches and six (6) inches sizes used in open cut installations, fittings may be supplied with bituminous or epoxy lining, in lieu of cement-mortar, and standard bituminous outer coatings. All ductile iron pipe and fittings used in trenchless installations shall have a polyethylene lining conforming to the requirements of ASTM D1248 and a standard bituminous outer coating.

PART 3 - EXECUTION

3.1 DUCTILE IRON PIPE

A. The Contractor shall conform to the installation requirements of Section 02535 - Gravity Flow Sanitary Sewers, and Section 02735 - Sewer Service Connections.

B. The joining of push-on joint ductile iron pipe shall be performed in accordance with the AWWA Standard for Installation of Ductile Iron Water Mains, Section 9C. Instructions for assembly of push-on joints may vary according to the particular manufacturer. The procedure for joining pipe equipped with push-on joints must therefore be in accordance with the instructions of the manufacturer of the particular joint furnished.

C. For push-on ductile iron pipe, the inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the socket. A thin coating of gasket lubricant shall be applied to both the inside surface of the gasket and outside surface of the spigot. Gasket lubricant shall be as supplied by the particular manufacturer and approved by the Engineer.

D. For mechanical joint pipe and fittings, the ends of the two (2) pieces of pipe to be joined (outside 8" of spigot and inside 8" of bell) shall first be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter, and then shall be painted with a soap solution made by dissolving one-half (½) cup of granulated soap in one (1) gallon of water. The ductile iron gland shall then be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket end. The rubber gasket shall be painted with the soap solution and placed on the spigot end with the thick edge toward the gland. The entire section of the pipe shall be pushed forward to seat the spigot end in the bell. The gasket shall then be pressed in place within the bell, care being taken to locate the gasket evenly around the entire joint. The ductile iron gland shall be moved along the pipe and into position for bolting, all of the bolts shall be inserted, and the nuts shall be fastened finger-tight. All nuts shall then be tightened with a suitable (preferable torque-limiting) wrench. Nuts spaced one-hundred and eighty (180) degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland. The torque for various sizes of bolts shall be as follows:

Bolt Size (inches)	Range of Torque (ft-lbs)
⅝	40 - 60
¾	60 - 90
1	70 - 100
1 ¼	90 - 120

3.2 FITTINGS

The Contractor shall install fittings in accordance with applicable ANSI/AWWA standards and manufacturers' recommendations.

3.3 TESTING

Following the installation of ductile iron pipe, the Contractor shall air test all sewer pipe joints in accordance with the requirements of Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers. Joints failing the air test are subject to rejection, repair, or replacement at the Contractor's expense.

END OF SECTION

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SECTION 02575

REMOVING AND REPLACING PAVEMENT

PART 1 - GENERAL

1.1 SCOPE

A. The work to be performed under this Section shall consist of existing pavement, sidewalks, steps, patios, curbs, and gutters in paved areas where such have been removed for construction of utilities and appurtenances.

B. Existing pavement, sidewalks, curbs, and gutters shall be replaced to meet the current City of Atlanta standards, or to match existing pavement sidewalk, curb, or gutters; whichever is more stringent.

1.2 SUBMITTALS

If required by the City or Engineer, provide certificates stating that materials supplied comply with Specifications. Certificates shall be signed by the asphalt producer and the Contractor.

1.3 CONDITIONS

A. Weather Limitations:
1. Apply bituminous tack coat only when the ambient temperature in the shade has been at least 50 degrees F for 12 hours immediately prior to application.
2. Do not conduct paving operations when surface is wet or contains excess of moisture that would prevent uniform distribution and required penetration.
3. Construct asphaltic courses only when atmospheric temperature in the shade is above 40 degrees F, when the underlying base is dry and when weather is not rainy.
4. Place base course when air temperature is above 35 degrees F and rising.

B. Grade Control: Establish and maintain the required lines and grades for each course during construction operations.

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

A. 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)

B. 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".

C. Tack Coat: Tack coat shall conform to Section 413 of the Georgia Department of Transportation Standard Specifications.

D. Binder Course: The binder course of all paved roadways shall conform to the requirements of Section 400, Type "B" of the Georgia Department of Transportation Standard Specifications.

E. Surface Course: The surface course for all pavement, including prime or tack coat when required by the Engineer, shall conform to the requirements of Section 400, Type "E" of the Georgia Department of Transportation Standard Specifications

F. Concrete: Provide concrete and reinforcing for concrete pavement or base courses in accordance with the requirements of the Georgia Department of Transportation Standard Specifications, Section 430. Concrete shall be minimum 3,000 psi compressive strength or as otherwise shown on the Drawings.

G. Special Surfaces: Where pavement, sidewalks, steps, patios, curbs, or gutters are disturbed or damaged which are constructed of specialty type surfaces, e.g., brick or stone, these facilities shall be restored utilizing similar, if not original, materials. Where the nature of these surfaces dictate, a specialty contractor shall be used to restore the surfaces to their previous or better condition. Special surfaces shall be removed and replaced to the limits to which they were disturbed.

2.2 TYPES OF PAVEMENTS

A. General: All existing pavement removed, destroyed or damaged by construction shall be replaced with the same type and thickness of pavement as that existed prior to construction, unless otherwise directed by the Engineer/Owner. Materials, equipment and construction methods used for paving work shall conform to the Georgia Department of Transportation specifications applicable to the particular type required for replacement, repair, or new pavements.

B. Aggregate Base: Aggregate base shall be constructed in accordance with the requirements of Section 310 of the Georgia Department of Transportation Standard Specifications. The maximum thickness to be laid in a single course shall be 6 inches compacted. If the design thickness of the base is more than 6 inches, it shall be constructed in two or more

courses of approximate equal thickness. After the material placed has been shaped to line, grade, and cross section, it shall be rolled until the course has been uniformly compacted to at least 100 percent of the maximum dry density when Group 2 aggregate is used, or to at least 98 percent of maximum dry density when Group 1 aggregate is used.

C. Concrete Pavement: Concrete pavement or base courses shall be replaced with concrete. The surface finish of the replaced concrete pavement shall conform to that of the existing pavement. The surface of the replaced concrete base course shall be left rough. The slab depth shall be equivalent to the existing concrete pavement or base course, but in no case less than 6 inches thick. Transverse and longitudinal joints removed from concrete pavement shall be replaced at the same locations and to the same types and dimensions as those removed. Concrete pavements or concrete base courses shall be reinforced.

D. Asphaltic Concrete Base, Bituminous Tack Coat, Binder, and Surface Course: Asphaltic concrete base, tack coat, and surface course construction shall conform to Georgia Department of Transportation Standard Specifications, Section 400. The pavement mixture shall not be spread until the designated surface has been previously cleaned and prepared; surface is intact, firm, properly cured, dry; and the tack coat has been applied. Apply and compact the base in maximum layer thickness by asphalt spreader equipment of design and operation approved by the Engineer/Owner. After compaction, the black base shall be smooth and true to established profiles and sections. Apply and compact the surface course in a manner approved by the Engineer/Owner. Immediately correct any high, low, or defective areas by cutting out the course, replacing with fresh hot mix, and immediately compacting to conform and thoroughly bond to the surrounding area.

E. Surface Treatment Pavement: Bituminous penetration surface treatment pavement shall be replaced with a minimum thickness of 1 inch conforming to Section 424, Georgia Department of Transportation Standard Specifications.

F. Gravel Surfaces: Existing gravel road, drive, and parking area replacement shall meet the requirements of graded aggregate base course. This surfacing may be authorized by the Engineer/Owner as a temporary surface for paved streets until replacement of hard surfaced pavement is authorized.

G. Temporary Measures: During the period between pavement removal and complete replacement of permanent pavement, maintain highways, streets, and roadways by the use of steel running plates anchored to prevent movement. The backfill above the pipe shall be compacted, as specified in Section 02200 of these Specifications, up to the existing pavement

surface to provide support for the steel running plates. All pavements shall be replaced within seven calendar days of their removal.

PART 3 - EXECUTION

3.1 LOCATIONS FOR PAVEMENT REPLACEMENT

A. Pavement Replacement:
   1. All trenches for roadway crossings
   2. All trench longitudinal installations
   3. All locations where pavement must be removed or is damaged in the execution of the Work

B. "Graded Aggregate" pavement repair shall be used only where approved by the Engineer/Owner.

3.2 REMOVING PAVEMENT

A. General: Remove existing pavement as necessary for installing the pipeline and appurtenances. Existing pavement and sub-base shall be removed for trench construction and pipe installation. Existing pavement on either side of the trench construction area shall be completely milled from edge of pavement to edge of pavement in order to replace pavement from edge of pavement to edge of pavement for all disturbed paved areas.

B. Remove and replace pavement and base to outer edge of existing pavement if existing pavement width is 24-inches or less from side of trench to outer edge of pavement.

C. Marking: Before removing any pavement, mark the pavement neatly paralleling pipelines and existing street lines. Space the marks the width of the trench

D. Saw Cutting: Under no circumstances shall the Contractor be allowed to remove concrete or asphalt without prior saw cutting. Asphalt pavement shall be saw cut along the marks using suitable equipment. The saw cutting shall be deep enough to produce an even, straight cut.

E. Breaking: Break asphalt pavement along the marks using pavement shearing equipment, jack hammers or other suitable tools. Break concrete pavement along the marks by scoring with a rotary saw and breaking below the score by the use of jack hammers or other suitable tools.

F. Machine Pulling: Do not pull pavement with machines until the pavement is completely broken and separated from pavement to remain.

G. Damage to Adjacent Pavement: Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement.

H. Sidewalks and Patios: Remove and replace any sidewalks or patios disturbed by construction for their full width and to the nearest undisturbed joint.

I. Curbs and Gutters: Tunnel under or remove and replace any curb and/or gutter, which is disturbed by construction to the nearest undisturbed joint.

J. Steps: Completely remove and replace any steps, constructed of concrete or special surfaces, which are disturbed by construction.

3.3 REPLACING PAVEMENT

A. Preparation of Subgrade: Upon completion of backfilling and compaction of the backfill, arrange to have the compaction tested by an independent testing laboratory approved by the Engineer/Owner. After compaction testing has been satisfactorily completed, replace all pavements, sidewalks, and curbs removed.

1. The existing street pavement or surface shall be removed or milled along the lines of the work from edge of pavement to edge of pavement. Pavement shall be replaced from edge of existing pavement to edge of existing pavement.
2. Trench backfill shall be compacted for the full depth of the trench as specified in Section 02200/02575 of these Specifications.
3. Temporary trench backfill along streets and driveways shall include 6 inches of crushed stone or cherty clay as a temporary surfacing of the trenches. This temporary surface shall be maintained carefully at grade, dust free, by the Contractor until the backfill of the trench has thoroughly compacted in the opinion of the Engineer/Owner, and permission is granted to replace the street pavement.
4. When temporary crushed stone or chert surface is considered by the Engineer/Owner to be sufficient surface for gravel pavement, the surface shall be graded smooth and to an elevation that will make the final permanent surfacing level with the adjacent surfacing that was undisturbed.

B. Pavement Replacement:

1. Prior to replacing pavement, make a final cut in concrete pavement 12 inches back from the edge of the damaged pavement with a concrete saw. Remove asphalt pavement 12 inches back from the edge of the damaged pavement using pavement shearing equipment, jackhammers or other suitable tools.

2. Replace and repave all street and roadway pavement from edge of pavement to edge of pavement as shown on the Drawings; as shown on the details contained herein. Replace driveways, sidewalks, and curbs with the same material, to nearest existing undisturbed construction joint and to the same dimensions as those existing.
3. If the temporary crushed stone or chert surface is to be replaced, the top 6 inches shall be removed and the crushed stone surfacing for unpaved streets or the base for the bituminous surface shall be placed.
4. Following this preparation, the chert or crushed stone base shall be primed with a suitable bituminous material and surfaced with the proper type of bituminous surface treatment.
5. Where the paved surface is to be replaced with asphaltic concrete pavement, concrete pavement or with a concrete base and a surface course, the temporary chert or crushed stone surface and any necessary backfill material, additional existing paving and new excavation shall be removed to the depth and width shown on the Drawings/details. All edges of the existing pavement shall be cut to a straight, vertical edge. Care shall be used to get a smooth joint between the old and new pavement and to produce an even surface on the completed street. Concrete base slabs and crushed stone bases, if required, shall be placed and allowed to cure for three days before bituminous concrete surface courses are applied. Expansion joints, where applicable, shall be replaced in a manner equal to the original joint.
6. Where driveways or roadways, constructed of specialty type surfaces, e.g., brick or stone are disturbed or damaged, these driveways and roadways shall be restored utilizing similar materials. Where the nature of these surfaces dictate, a specialty contractor shall be used to restore the surfaces to their previous or better condition. Special surfaces shall be removed and replaced to the limits to which they were disturbed.

C. Pavement Resurfacing:
1. After all pipe line installations are complete and existing pavement has been removed or milled from edge of pavement to edge of pavement, apply tack coat and surface course as specified.
2. Resurfacing limits shall be perpendicular to the road centerline. The limits of resurfacing shall be 10 feet beyond the edge of the pavement replacement on the main road being resurfaced.
3. Where pavement damaged with potholes, the Contractor shall remove all existing loose pavement material and fill the hole with black base, as specified, to the level of the existing pavement.

D. Pavement Striping: Pavement striping removed or paved over shall be replaced with the same type, dimension, and material as original unless directed otherwise by the Engineer/Owner.

E. Installation of Traffic Plates: Following completion of sewer works including backfilling but prior to replacement of pavement, steel plates shall be used to temporarily carry vehicular traffic as follows:

1. All Steel plates shall meet ASTM structural specifications having "A36" designation with minimum yield stress of 36 ksi (ksi = kilopounds per square inch).
2. Asphaltic patching material (cold mix) shall be used to secure the steel plate around its edges. Alternatively, all sides of the plate or plates must be secured to the ground surface with A.R.E.A. standard railroad spikes. No spikes shall be left lying on the highway.
3. Trench must be backfilled to within eight (8) inches from top of existing pavement prior to placing the steel plate.
4. No plate is allowed over a trench having a width greater than 48 inches when adequate soil conditions are present. When the trench is greater than 48 inches, the entire lane containing the trench shall be closed. Before closing a lane, a "Lane Closure Permit" must be obtained from the City of Atlanta, Department of Public Works, Bureau of Traffic and Transportation. At least 24 hours prior notification is required for the "Lane Closure Permit".
5. All necessary warning signs, barricades, and lights shall be adequately provided and placed for the safety of the public and in full conformity with the MUTCD at no additional cost to the City. Before closing a "Lane Closure Permit" must be obtained from the City of Atlanta. The Department of Public Works, Bureau of Traffic and Transportation must be notified at least 24 hours in advance.
6. The width of a trench is measured normal to the length of the trench. The largest reading of the measurements is the determining factor for width. For a series of steel plates on any continuous trench, all plates must have the same thickness.
7. Trench must be fully covered with a minimum of twelve (12) inches of asphalt taper on all sides of the plate.
8. Upon the completion of the work, the existing surface shall be cleaned and pavement restored to the City of Atlanta standards.

3.4 SIDEWALK, CURB, AND GUTTER REPLACEMENT

Conform with requirements of Section 02521.

3.5 MAINTENANCE

The Contractor shall maintain the surfaces of roadways built and pavements replaced until the acceptance of the Project. Maintenance shall include replacement, scraping, reshaping, wetting, and re-rolling as necessary to prevent raveling of the road material, the preservation of reasonably smooth surfaces and the repair of damaged or unsatisfactory surfaces, to the satisfaction of the Engineer. Maintenance shall include sprinkling as may be necessary to abate dust from the gravel surfaces.

3.6 SUPERVISION AND APPROVAL

A. Pavement restoration shall meet the requirements of the regulatory agency responsible for the pavement. Obtain agency approval of pavement restorations before requesting final payment.

B. Obtain the Engineer's/Owner's approval of restoration of pavement, such as private roads and drives that are not the responsibility of a regulatory agency.

C. Complete pavement restoration as soon as possible after backfilling.

D. Failure of Pavement: Should any pavement restoration or repairs fail or settle during the life of the Contract, including the bonded period, promptly restore or repair defects.

E. Prior to acceptance and approval of any asphaltic concrete binder and/or topping which is installed for the purpose of City maintenance, a representative of the City of Atlanta's Department of Traffic and Transportation may require one or all of the following tests: 1) coring, 2) extraction, 3) compaction, 4) density. The frequency and location of these tests will be left up to the discretion of the Inspector/Engineer.

3.7 CLEANING

The Contractor shall remove all surplus excavation materials and debris from the street surfaces and rights-of-way and shall restore street, roadway, or sidewalk surfacing to its original condition.

END OF SECTION

SECTION 02600
WASTEWATER FLOW CONTROL

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of wastewater flow control; plugging and blocking; pumping and bypassing; flow control precautions; and any other similar, incidental, or appurtenant flow control operation which may be necessary to properly complete the Work as shown on the Drawings and Specified herein.

B. The Contractor shall provide all services, labor, materials, and equipment required for all flow control and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. Section 01200 - Measurement and Payment
3. Section 02115 – Cleaning of Existing Pipes
4. Section 02535 - Gravity Flow Sanitary Sewers
5. Section 02650 - Testing for Acceptance of Sanitary and Storm Sewers
6. Section 02735 – Sewer Service Connections

1.2 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 design, installation, and operation of the wastewater flow control system shall be the Contractor's responsibility. The Contractor shall employ the services of a vendor that can demonstrate to the Engineer that the vendor specializes in the design and operation of wastewater flow control systems. The vendor shall provide at least three (3) references of projects of a similar size and complexity as this Project, which were successfully performed by the vendor's firm within the past three (3) years. The references shall include the name of the agency, the name of the project, the date of the project, and the agency contact (telephone, fax, and e-mail). The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

2. A general description of the proposed Wastewater Flow Control to include the make and model of temporary bypass pumps, the certified noise levels

of the pumps and generator, the means used to maintain and operate the bypass pumps, and a written statement that all bypass pumping shall comply with the requirements of these Specifications.

3. During the course of the project, the detailed, work-specific Wastewater Control Plan utilizing multiple pumps, or a single pump greater than four (4) inches discharge, shall be submitted to the Engineer at least ten (10) days before required. This plan shall outline all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. This plan shall be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials, and all other incidental items necessary and/or required to insure adequate wastewater control. The plan shall also include details of protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Specifications. No construction shall begin until all provisions and requirements have been reviewed and accepted by the Engineer.

4. The Contractor shall submit two (2) copies of the wastewater control plan for each sewer bypass set-up with sufficient detail including the following:

    a. Staging areas for pumps.

    b. Sewer plugging method and types of plugs.

    c. Number, size, material, location, and method of installation of suction piping.

    d. Bypass pump sizes, capacity, number of each size to be on the site of the Work and power requirements.

    e. Calculations of static lift, friction losses, and flow velocity (pump curves) showing pump-operating range.

    f. Standby power generator size and location.

    g. Downstream piping and discharge plan.

    h. Method of protecting discharge manholes or structures from erosion and damage.

    i. Thrust and restraint block sizes and locations.

    j. Sections showing suction and discharge pipe depth, embedment, select fill, and special backfill where required.

k. Certified decibel levels of individual pumps, the combined decibel level if multiple pumps will be operated simultaneously, and the method of noise control for each pump and/or generator.

l. Any temporary pipe supports, including rollers and elevated rollers, as well as anchoring required.

m. Design plans and computations for access to bypass pumping locations.

n. Calculations for selection of bypass pumping pipe size.

o. Schedule for installation of and maintenance of bypass pumping lines.

p. Plan indicating selection location of bypass pumping line locations.

q. The Plan shall indicate the means by which flows from laterals are provided for either by plugging, containing, or subsidiary pumping. Building laterals shall not be disconnected or plugged overnight. Plugging of laterals is only allowed from 9 a.m. until 5 p.m. of the same day.

5. Any proposal to implement wastewater flow control arrangements on sewers, including plugging and/or blocking, high-velocity nozzles, and/or bypass and/or diversion pumping as well as any sewer rehabilitation, repair, or replacement construction, shall be outlined in writing and submitted to the Engineer at least ten (10) days prior to the implementation of the wastewater flow control system, sewer rehabilitation, repair, or replacement.

6. All proposed wastewater flow control arrangements, including flow bypass and/or diversion plans, shall indicate or show the location and position, in detail if necessary, any special features where pipes or hoses cross roadways, including intersections, such as temporary trenches, support bridges, ramp-overs, etc.

7. All proposed wastewater flow control arrangements, including wastewater flow bypass and/or diversion pumping plans for sewers, shall also include an emergency response plan to be followed in the event of a failure of the wastewater flow control system. The Contractor shall provide names and phone numbers for twenty-four (24) hour emergency contact.

8. The Contractor shall notify the Engineer twenty-four (24) hours prior to commencing actual wastewater flow control operations. The Contractor's Wastewater Flow Control Plan shall be approved by the Engineer before the Contractor shall be allowed to commence wastewater flow control

work.

1.3 GENERAL

The objective of wastewater flow control is to:

A. Maintain an efficient and uninterrupted level of service to wastewater collection system users while maintenance or construction operations (including rehabilitation, repair, replacement, or connection of newly constructed facilities) are facilitated on the segment or segments being bypassed and/or from which flow is being diverted, within the wastewater collection system.

B. Ensure that all levels of wastewater flow are continuously and effectively handled around the segment or segments of sewer being bypassed and/or from which flow is being diverted by:
   1. Ensuring that bypass and diversion pumps are adequately fueled, lubricated, and maintained.
   2. Ensuring backup spare parts are expeditiously applied to the flow bypass and/or diversion pumping system in the event of component breakdown.
   3. Ensuring that an emergency backup plan is smoothly implemented in the event of system failure.
   4. Preventing backup, spillage, flooding, or overflow onto streets, yards, and unpaved areas or into buildings; adjacent ditches; storm sewers; and waterways; while flow bypass or diversion pumping takes place and ensuring that installation, startup, and subsequent disassemby of the flow bypass and diversion pumping system is smoothly transitioned.

1.4 REGULATORY REQUIREMENTS

A. The work of this section shall comply with the current versions, with revisions, of the following:

   OSHA 29 CFR 1910.146 (permit-required confined-space regulations)

B. All Work and testing shall comply with the applicable Federal codes, including Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended, and applicable state and local codes and standards; and to the extent applicable with the requirements of the Underwriter's Laboratories, Inc. and the National Electric Code.

PART 2 - PRODUCTS

2.1 PIPE FOR FLOW DIVERSION

A. Ductile Iron Pipe: Ductile iron pipe as specified in Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings is acceptable for use for flow diversion during construction.

B. Polyethylene Pipe: Polyethylene material shall comply with the requirements for Type III polyethylene, C-5 and P-34 as tabulated in ASTM D1248 and have the Plastic Pipe Institute recommended designation PE3406. The material shall also have an average specific base resin density of between 0.94 g/cc and 0.955 g/cc (ASTM D1505). Pipe made from these resins must have a long term strength (50 years) rating of 1,250 psi or more per hydrostatic design basis categories of ASTM D2837. The polyethylene resin shall contain antioxidants and be stabilized against ultraviolet degradation to provide protection during processing and subsequent weather exposure. The polyethylene resin shall have an environmental stress crack resistance, condition C as shown in ASTM D1693, to be greater that five-hundred (500) hours, twenty (20) percent failure. All pipe shall be made from virgin quality material. No rework compound, except that obtained from the manufacturer's own production of the same formulation shall be used. The polyethylene resin shall have an average melt flow index, condition E as shown in ASTM D1238, not in excess of 0.25 g/10 min. Pipe shall be homogeneous throughout, and free of visible cracks, holes, foreign material, blisters, or other deleterious faults. Diameters and wall thickness shall be measured in accordance with the requirements of ASTM D2122. Pipe joining will be done by thermal butt fusion method in accordance with the requirements of ASTM D657.

2.2 PUMPING EQUIPMENT

A. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric or diesel powered, provided they meet all specified sound level requirements. If electric pumps are used, the combined generator/pump system shall meet the specified sound level requirements. All pumps used shall be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.

B. Unless specified otherwise in these Specifications or approved by the Engineer, all pumps (and generators if used) shall be fully sound attenuated and shall produce a noise level of sixty-five (65) dBA or less at a distance of twenty-three (23) feet.

C. The Contractor shall provide the necessary stop/start controls for each pump.

D. The Contractor shall include one stand-by pump of each size to be maintained on site of the Work. Back-up pumps shall be on-line, isolated from the primary system by a valve.

E. The Contractor shall design all piping, joints, and accessories to withstand twice the maximum system pressure or fifty (50) psi, whichever is greater. The back-up pump, appropriate piping, fuel, lubrication, and spare parts shall be incorporated into the bypass arrangement at the site of the Work, ready for use in case of breakdown. A bypass "drill" shall be carried out by the Engineer before the bypass arrangement is accepted on all sewers greater than twelve (12) inches in diameter, at no cost to the City. The drill shall demonstrate the incorporation of all standby equipment to handle flows when the main pump set is switched off. The Engineer's instructions following the drill shall be adhered to in full at no cost to the City.

F. No more than two (2) pump discharge hoses shall be used for wastewater flow control over a length of the line segment(s). If the flow exceeds the capacity of (2) "hoses" then rigid piping shall be used. The rigid piping shall consist of Ductile Iron Pipe, HDPE, or steel pipes with suitable pressure rated couplings to withstand twice the maximum system pressure or fifty (50) psi, whichever is greater.

G. Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer.

2.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Bypass pumping systems shall have sufficient capacity to pump peak flows in the pipes being bypassed (flows in the existing sewers can increase dramatically during periods of wet weather). The Contractor shall provide all pipeline plugs, pumps of adequate size to handle wet weather peak flows, and temporary discharge piping to ensure that the total flow of the mainline is safely diverted around the section to be repaired. Wastewater flow control system will be required to be operated twenty-four (24) hours per day.

2. Bypass pumping systems used to temporarily pump completed portions of the newly separated sewer into the existing combined trunk shall be sized using the COA Gravity Sewer Design Guide, latest revision available.

3. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One (1) standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure.

4. The wastewater flow control system shall be capable of bypassing flow around the work area and of releasing any amount of flow, up to full available flow, into the work area as necessary for satisfactory performance of the Work.

5. The Contractor shall make all arrangements for bypass pumping during the time when the mainline is shut down for any reason. The wastewater flow control system shall overcome any existing force main pressure on discharge.

B. Performance Requirements:

1. It is essential to the operation of the existing wastewater system that there is no interruption in the flow of wastewater throughout the duration of the project. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the wastewater flow before it reaches the point where it would interfere with the Work, carry it past the Work, and return it to the existing sewer downstream of the work.

2. The design, installation, and operation of the wastewater flow control system shall be the Contractor's responsibility. The wastewater flow control system shall be the Contractor's responsibility.

3. The Contractor shall provide all necessary means to safely convey the wastewater past the work area. The Contractor will not be permitted to stop or impede the mainline flows under any circumstances.

4. The Contractor shall maintain wastewater flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers, and that will protect public and private property from damage and flooding.

5. The Contractor shall protect water resources, wetlands, and other natural resources.

PART 3 - EXECUTION

3.1 PLANNING

The Contractor shall be solely responsible for planning and executing all wastewater flow control operations. The Contractor shall be entirely liable for damages to private or public property that may result from his operations and for all cleanup, disinfection, damages, and resultant fines in the event of a spillage, flooding, or overflow.

3.2 GENERAL

A. All materials used for wastewater flow control shall be pre-approved by the Engineer prior to commencing wastewater flow control activities.

B. Before any wastewater flow control equipment is installed, the Contractor shall desilt the segment of sewer to be bypassed while it is still under flow. Subsequent jetting and final cleaning before rehabilitation or repair shall be undertaken while the segment of sewer is bypassed.

C. The Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbances to existing utilities and shall obtain approval of the pipeline locations from the Engineer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor.

D. During all wastewater flow control operations, the Contractor shall protect mainlines, manholes, and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to mainlines, manholes, and all local sewer lines caused by human or mechanical failure.

E. When wastewater flows at the upstream manhole of the manhole section being repaired are above the maximum allowable requirements for television inspection, or do not allow the proper sewer or manhole repair, the flows shall be reduced to the levels required by one of the following methods: plugging/blocking of the flows, or pumping/bypassing of the flows as approved by the Engineer.

F. In some applications, the wastewater flow may be plugged and contained within the capacity of the collection system. This shall only be done when it has been determined, by the Engineer, that the system can accommodate the surcharging without any adverse impact.

G. If required by the Engineer, for television inspection, before abandoning a sewer, the Contractor shall block the sewer line completely. No flow, except infiltration/inflow, will be allowed through the respective sewer line being televised.

H. When sewer line flows are too excessive to plug while service lines are being removed and reconnected to the new sanitary sewer, the Contractor shall submit a written plan and pump/bypass the flow as acceptable to the Engineer.

I. When existing combined, storm, or sanitary sewers are required to be taken up, moved, or rebuilt, the Contractor, at his own expense, shall provide and maintain temporary outlets and connections for all private or public drains, sewers, and sewer outlets connected to or served by the sewers to be rebuilt, and where necessary, shall provide adequate pumping facilities; and shall maintain these services until such time as the permanent sewers and connections are built and in

service at no cost to the City.

J. During construction, flows in sections of the existing combined sewer being rehabilitated/repaired by removal and replacement shall be accommodated by temporary flow diversion. Wastewater flow diversion shall be accomplished as specified in this section, unless otherwise shown on the Plans.

K. The Contractor shall use the provided construction easement for the flow diversion if not otherwise shown on the Plans. It shall be the Contractor's option to lay diversionary pipe within the construction easement. The Contractor shall use ingenuity and skill to develop a flow diversion program. The program must keep the wastewater flowing without discharge or spills into receiving waters or on the ground. The Contractor shall seek and obtain inspection of each section of newly laid sewer before taking the diversion out of service and placing the newly laid section in service.

L. In sections of the existing combined sewer being rehabilitated/repaired by laying a new line parallel to the existing combined sewer, the existing sewer may be used to accommodate the existing flow, and no temporary flow diversion will be necessary if the existing combined sewer is not damaged or its use restricted by the Contractor's operations.

M. All pipe materials utilized in wastewater flow diversion during construction shall be in good condition, and free of defects and leaks. Any defective material shall be replaced by the Contractor at no cost to the City. Upon completion of the job, pipe materials shall be removed from the site.

N. The Contractor shall complete all wastewater flow control activities with the minimum sound level compatible with accepted industry standards for sound attenuated temporary pumping systems.

O. When pumps are operating, an experienced bypass/diversion pump maintenance operator, mechanic, and/or assistant shall continuously be on site to monitor the operation of the entire bypass/diversion system. The operator, mechanic, and/or assistant shall comprehensively, methodically, and continuously:

1. Adjust pump speed as appropriate so as not to adversely impact upstream or downstream flow condition levels.

2. Check that the effectiveness and security of bulkheads, dams, diaphragms, plugs, valves, weirs, and all other flow control devices are working effectively and according to plan.

3. Check the integrity of hoses and couplings along the entire bypass/diversion system.

4. Monitor fuel tanks and top up as appropriate.

5. Monitor lubrication levels and top up as necessary.

6. Facilitate minor repairs as required.

7. Report on potential problems arising.

8. Inspect bypass-pumping system at least hourly to ensure that the system is working correctly.

9. Maintain adequate supply of spare parts on site as required.

3.3 DEPTH OF FLOW

A. In performing television inspection, joint testing, and joint sealing work, the Contractor shall control the depth of flow in the sewer within the following guidelines:

MAXIMUM PIPE FLOW DEPTH			
TELEVISION INSPECTION		JOINT TESTING AND SEALING	
PIPE SIZE	% PIPE DIA.	PIPE SIZE	% PIPE DIA.
6"-10"	20	6"-12"	25
12"-24"	25	15"-24"	30
27" or larger	30	27" or larger	35

B. When sewer line flows, as measured in the first manhole upstream of the sewer segment being rehabilitated, televised, or tested exceed the maximum depth listed above or inspection of the complete pipe periphery is necessary for effective testing, sealing, or line work, the Contractor shall implement wastewater flow control methods at no additional cost to the City.

3.4 PLUGGING AND BLOCKING

The Contractor shall insert a sewer line plug into the line at a manhole upstream from the section being inspected or repaired. The plug shall be so designed that all or any portion of the operation flow can be released. During the inspection portion of the operation, flows shall be shut off or reduced to within the maximum flow limits specified. During repairs, the flows shall be shut off or pumped/bypassed, as approved by the Engineer. Wastewater flow shall be restored to normal following completion of work within the subject manhole to manhole section.

3.5 PUMPING AND BYPASSING

A. When Bypass Pumping is required, a pump size shall be recommended by the Contractor and approved by the Engineer. The Contractor shall supply the necessary pumps, conduits, and other equipment to divert the flow of wastewater around the manhole section in which the Work is to be performed. The bypass system shall be of sufficient capacity to handle existing flows plus additional flow that may occur during periods of rainstorms. The Contractor shall be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. A "setup" consists of the necessary pumps, conduits, and other equipment required to divert the flow of wastewater around a manhole to manhole section, from the start to finish of work performed in the manhole to manhole section.

B. Wastewater shall be pumped directly into the nearest available downstream manhole, provided that the existing sewer has capacity to transport the flow. The Contractor shall be responsible for keeping the pumps running continuously twenty four (24) hours a day if required, until the bypass operation is no longer required. The Contractor shall have standby pumps at all times.

C. Pumps and equipment shall be continuously monitored by a maintenance person capable of starting, stopping, refueling, and maintaining these pumps during the bypassing operations. If pumping is required on a twenty four (24) hour basis, engines shall be equipped in a manner to keep noise to a minimum.

3.6 FLOW CONTROL PRECAUTIONS

A. Where the wastewater flow is blocked or plugged, the Contractor shall be responsible for taking sufficient precautions to protect public health. The sewer lines shall also be protected from damage. The following shall apply:

1. No wastewater shall be allowed to back up into any homes or buildings.

2. No wastewater shall overflow any manholes, cleanouts, or any other access to the sewers.

3. No interruption of water and sewer utilities users upstream of the inspection/repair area shall be allowed to occur.

4. If any of the above occur or are expected to occur, the Contractor shall provide bypass pumping to alleviate one or all of the conditions. Additionally, the Contractor shall observe the conditions upstream of the plug and be prepared to immediately start bypass pumping, if needed.

B. Any sump pumps, bypass pumps, trash pumps, or any other type of pump which pulls wastewater or any type of material out of the manhole or sewer shall discharge the material into another manhole, or appropriate vehicle or container approved by the Engineer. Under no circumstances shall this material be discharged, stored, or deposited on the ground, swale, road, or open environment.

C. The Contractor shall take appropriate steps to ensure that all pumps, piping, and hoses that carry raw wastewater are protected from traffic.

D. In the event, during any form of "Wastewater Flow Control," that raw wastewater is spilled, discharged, leaked, or otherwise deposited in the open environment, due to the Contractor's work, the Contractor shall be responsible for any cleanup of solids and stabilization of the area affected. This work shall be performed at the Contractor's expense with no additional cost to the City. The Contractor shall also be responsible for notifying the sewer system maintenance personnel and complying with any and all regulatory requirements for cleaning up the spill at no additional cost to the City.

E. During wastewater flow control operations, the Contractor shall take proper precautions to prevent damage to existing sanitary sewer facilities, flooding, or damage to public or private property.

F. The Contractor shall make repairs or replacements or rebuild such damaged section or sections of existing sewers, as directed by the Engineer. All such repairs, replacements, and rebuilding shall be paid for by the Contractor.

G. The Contractor shall make such provisions as are necessary for handling all flows in existing sewers, connections, and manholes by pipes, flumes, or by other approved methods at all times, when his operations would, in any way, interfere with normal functioning of those facilities.

H. The Contractor shall be responsible for the removal of any debris and sedimentation in the existing sewers, laterals, and manholes, etc., which is attributable to the Work.

I. All operations shall be performed by the Contractor in strict accordance with OSHA and any applicable local safety requirements. Particular attention is directed to safety regulations for excavations and entering confined spaces.

J. It is the Contractor's responsibility to notify in writing any property owner having a sewer service connection being reconnected to the new sanitary sewer that such work is being performed. The Contractor shall notify property owners forty eight (48) hours prior to commencing service reconnection. The Contractor shall be solely responsible for any damage caused by property service connection backups caused by his Work.

K. Piping used for temporary flow diversion of storm, combined, or gravity sewers shall not be used for temporary flow diversion of potable water.

END OF SECTION

SECTION 02607

MANHOLES, JUNCTION BOXES, CATCH BASINS AND INLETS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required to install cast-in-place, and precast concrete manholes, junction boxes, catch basins and inlets. The term manholes, as used, herein and shown on the Drawings includes manholes, junction boxes, catch basins and inlets. All work shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Related Work Specified Elsewhere:
1. Section 02200, Earthwork.
2. Section 02641, Precast Concrete Manholes.
3. Section 03200, Concrete Reinforcement and Dowelling.
4. Section 03300, Cast-In-Place-Concrete.
5. Section 03450, Precast Concrete Units.

1.2 SUBMITTALS

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

Complete shop drawings and engineering data on frames, covers, steps and precast manhole sections and flotation calculations shall be submitted to the Engineer in accordance with the requirements of the General Conditions of the Contract Documents.

1.3 QUALITY ASSURANCE

A. Prior to delivery, all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory or, if approved by the Engineer, certified copies of test reports prepared by the manufacturer's testing laboratory will be acceptable. All materials which fail to conform to these Specifications shall be rejected.

B. After delivery to the site, any materials which have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the site.

1.4 QUALITY STANDARDS

Manufacturers offering products that comply with these specifications include:

A. Standard manhole frame and cover.
   1. Vulcan Foundry, VM-26.
   2. Neenah Foundry, Series R-1700.
   3. Or equal.

B. Manhole adjusting rings.
   1. Neenah Foundry, R1979-H.
   2. Higgins Foundry,
   3. Or equal.

C. Manhole rungs.
   1. M.A. Industries.
   2. Or equal.

1.5 WARRANTY

Provide a warranty against defective materials and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

Manholes shall be constructed of specified materials to the sizes, shapes and dimensions and at the locations shown on the Drawings or as otherwise directed by the Engineer. The height or depth of the manhole will vary with the location, but unless shown otherwise on the Drawings, shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface and the invert will be at the designated elevations.

2.2 MATERIALS AND CONSTRUCTION

A. Concrete and Reinforcement:
   1. Concrete used in manhole and junction chamber construction shall be Class B 5,000 psi concrete conforming to the requirements of Section 03300, Cast-In-Place Concrete.
   2. Steel reinforcement shall conform to the requirements of Section 03200, Concrete Reinforcement and Dowelling.
   3. Brick. The brick shall conform to the requirements of AASHTO M 91.
   4. Mortar. The mortar for brick masonry and similar work shall be composed of 1 part of Portland cement and 2 parts of mortar sand, by

volume. The Portland cement shall conform to the requirements of AASHTO M 45. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15 percent of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C 6. The water shall be clean and free of deleterious amounts of acids, alkalis, or organic material. If the water is of questionable quality, it shall be tested in accordance with AASHTO T 26.

B. Precast Concrete Manholes:

1. Precast concrete manholes shall consist of precast reinforced concrete sections, a conical or flat slab top section, and a base section conforming with the typical manhole details as shown on the Drawings.
2. Precast manhole section shall be manufactured, tested and marked in accordance with the latest provisions of ASTM C 478.
3. The minimum compressive strength of all precast concrete units with Type II cement shall be 5,000 psi.
4. The maximum allowable absorption of the concrete shall not exceed 8 percent of the dry weight.
5. The circumferential reinforcement in the riser sections, conical top sections and base wall sections shall consists of one (1) line of steel and shall be not less than 0.17 square inches per lineal foot.
6. The ends of each reinforced concrete manhole riser section and the bottom of the manhole top section shall be so formed that when the manhole risers and the top are assembled, they will make a continuous and uniform manhole.
7. Joints of the manhole sections shall be of the tongue and groove type. Sections shall be joined using 0-ring rubber gaskets conforming to the applicable provisions of ASTM C443, latest revision, or filled with an approved preformed plastic gasket meeting the requirements of Federal Specifications 55-5-00210, "Sealing Compound, Preformed Plastic for Pipe Joints", Type 1, Rope Form.
8. Each section of the precast manhole shall have not more than two (2) holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.
9. Polypropylene plastic manhole steps shall be installed in each section of the manhole in accordance with the standard details included with the Drawings.

C. Brick Structures:

1. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Section 03300. The foundation shall be built to the

correct elevation and shall be finished to cause the least possible resistance to flowing water.

2. Laying Brick. All brick shall be clean and thoroughly wet before laying so that the brick will not absorb any appreciable amount of additional water at the time laid. All brick shall be laid in freshly made mortar. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it which can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

3. Joints. All joints shall be slushed with mortar at every course but slushing alone will not be considered adequate for making an acceptable joint. Exterior faces shall be laid up in advance of backing. Exterior faces shall be back plastered or pargeted with a coat of mortar not less than _-inch thick before the backing is laid up. Prior to pargeting, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than ¼-inch nor more than ½-inch wide and whatever width is adopted shall be maintained uniform throughout the work.

4. Pointing. Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

5. Cleaning. Upon completion of the work, all exterior surfaces shall be thoroughly cleaned by scrubbing and washing down with water and, if necessary, to produce satisfactory results, cleaning shall be done with a 5 percent solution of muriatic acid which shall then be rinsed off with liberal quantities of clean fresh water.

6. Curing and cold weather protection. In hot or dry weather, the brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost in the brick or when the air temperature is below 50 degrees F unless the Contractor has on the project, ready to use,

suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60 degrees F for the duration of the curing period.

D. Frames and Covers:

1. Frames and covers shall be cast iron conforming to the minimum requirements of Federal Specifications WWOI-652 or to ASTM A 48 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 and/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 a bituminous paint. Each casting shall have its actual weight in pounds stenciled or painted on it in white paint.
2. Standard manhole frames and covers shall have a minimum of 22-inches clear inside diameter (unless otherwise shown in the Drawings, in which case the greater value shall be used)) and shall be a minimum of 5-inches high, with guide ring, and shall weigh not less than 446 pounds, total. Manhole covers shall be as detailed on the Drawings.
3. The contact surfaces of all manhole covers and the corresponding supporting rings in the frames shall be machined to provide full perimeter contact.
4. All sanitary and storm sewer manhole covers shall have the word "PROPERTY OF THE CITY OF ATLANTA" cast on the top in letters 1-inch high.
5. An adjusting ring shall be provided for each manhole in a street.
6. Provide solid manhole and handhole covers and frames for electrical underground systems. Covers shall have letters "HIGH VOLTAGE", "LOW VOLTAGE", "SIGNAL", as applicable, embossed on top.

PART 3 - EXECUTION

3.1 CONSTRUCTION OF CAST-IN-PLACE CONCRETE MANHOLES

A. Cast-in-place manholes, excluding curved manhole bases, shall be constructed in place with the base, barrel, and conical section all monolithically cast using removable forms of material and design approved by the Engineer.

B. The vertical forms, vertical and horizontal wall spacers, steps and placing cone must be carefully positioned and firmly clamped in place before any placement is made. The wall spacers must be located 90 degrees from each other. The forms shall be firmly supported with bottom of forms at the proper elevation to permit the base to be deposited through the vertical forms.

C. No pipe penetration shall be formed within 12-inches of a corner, for square bases, or within 12-inches of another penetration, in any direction, for circular bases.

D. The manhole base shall be deposited down through the wall forms onto undisturbed earth or rock bearing. It shall be evenly distributed around the walls and vibrated both inside and outside the forms until there is a minimum slope of 60 degrees from the bottom of the forms to the bearing surface both inside and outside of the manhole. When this is complete and before additional concrete is added, the concrete must be carefully vibrated on each side of each sewer pipe.

E. The base shall be concentric with the manhole, except where eccentric alignment with the ladder is required, and have a minimum diameter of 4-feet or 16-inches greater than the outside diameter of the manhole whichever is greater, and 10-inch minimum thickness under the lowest pipe. Minimum wall thickness shall be 6-inches.

F. Additional concrete must be deposited in evenly distributed layers of approximately 18-inches with each layer vibrated to bond it to the preceding layer. The wall spacers must be raised as the placements are made. The concrete in the area from which the spacer is withdrawn shall be carefully vibrated. Excessive vibration shall be avoided.

G. Adjustment rings shall be provided between the conical section and the manhole frame. The rings shall be cast-in-place using building felt between pours to create a weakened joint or as directed by the Engineer. If adjustment of the lid elevation is called for, concrete adjusting rings shall be used.

H. All manhole bases, including curved manhole bases and inverts shall be constructed of Class "B" concrete in accordance with details on the Drawings. Inverts shall be smooth and accurately shaped and have the same cross section as the invert of the sewers which they connect. The manhole base and invert shall be carefully formed to the required size and grade by gradual and even changes in sections, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations. Changing directions of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit. The invert and flow channel shall be formed during or immediately after the placing of the concrete and brush-finished as soon as the concrete has sufficiently set.

I. Form marks and offsets shall not exceed 1-inch on the outside surface of the manhole. Form marks and offsets shall not exceed 1/2-inch inside of the manhole. All offsets on the inside surface of the manhole shall be smoothed and rubbed so there is no projection or irregularity capable of scratching a

worker or catching and holding water or other materials. Honeycombed areas shall be completely removed immediately upon removal of the forms and replaced with a Class "B" concrete as directed by the Engineer or patched with epoxy grout.

J. Should circumstances make a joint necessary, a formed groove or reinforcing dowels shall be required in the top of the first placement for shear protection. Immediately before the second placement is made, the surface of the cold joint shall be thoroughly cleaned and wetted with a layer of mortar being deposited on the surface.

K. Concrete setting time and backfilling shall be in accordance with the applicable requirements of Section 03300. Masonry work shall be allowed to set for a period of not less than 24 hours. Outside forms, if any, then shall be removed and the manhole backfilled and compacted. All loose or waste material shall be removed from the interior of the manhole. The manhole cover then shall be placed and the surface in the vicinity of the work cleaned off and left in a neat and orderly condition.

3.2 CONSTRUCTION OF PRECAST CONCRETE MANHOLES

A. After placing manhole base, inverts shall be constructed using Class "B" concrete and 3 to 5 inches slump range in accordance with details on the Drawings, and inverts shall have the same cross section as the invert of the sewers which they connect. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections. Changes in directions of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit.

B. After the base section has been set, and inverts have been formed, the precast manhole sections shall be placed thereon, care being exercised to form the incoming and outgoing sewer pipes into the wall of the manhole at the required elevations.

C. The cast iron frame for the manhole cover shall be set at the required elevation and properly anchored to the riser section. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted to conform to the exact slope, crown and grade of the existing adjacent pavement.

D. After backfilling has been completed, the excavated area, if located in a street, alley or sidewalk, shall be provided with a temporary surface.

3.3 MANHOLES OVER EXISTING SEWERS

A. Construct manholes over existing operating sewer lines at locations shown. Perform necessary excavation as specified hereinbefore, break into existing line, and construct manhole.

B. Maintain flow through existing sewer lines at all times and protect new concrete and mortar work for a period of 7 days after concrete has been placed. Advise Engineer of plans for diverting sewage flow and obtain Engineer's approval before starting. Engineer's approval will not relieve Contractor of responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

C. Construct the new base under the existing sewer and the precast sections as specified herein.

D. Break out the existing pipe within the new manhole, cover the edges with mortar, and trowel smooth.

3.4 INSPECTION AND TESTING

After completion, all manholes will be inspected. The Contractor shall make, at Contractor's expense, all necessary changes, modifications, and/or adjustments required to assure satisfactory operation.

+++ END OF SECTION +++

SECTION 02641

PRECAST CONCRETE MANHOLES

PART 1 - GENERAL

1.1 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 01200 - Measurement and Payment
2. Section 03300 - Cast-In-Place Concrete
3. Section 03450 - Precast Concrete Units

1.2 SUBMITTALS

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

The Contractor shall submit 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.

1.3 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.

Qualifications, Testing and Inspection

1. 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.
2. 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.

a. Slump: C143
b. Compressive Strength: C31, C192, and C39
c. Air Content (when air-entrained concrete is being used): C231 or C173
d. Unit Weight: C138

3. The Precast concrete producer shall provide documentation demonstrating compliance with this subparagraph.
4. The plant shall notify the Engineer when the pre-cast products are being produced for the project. The City may place an inspector in the plant when the products covered by this specification are being manufactured."

1.4 DESIGN CRITERIA

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 Drawings 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 Drawings and the invert will be at the designed elevations.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Unless specified otherwise in the Drawings 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. 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 5,000 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 City's representatives. The manhole manufacturer shall permit the City'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 City of all manholes delivered for use in the City's sanitary sewer system which were manufactured during a week for which a concrete compressive strength test yielded a result of less than 5,000 psi.
    a. Such notification shall be in the form of a letter sent to:

        City of Atlanta Department of Watershed Management
        Construction Management Group
        750 Selig Drive, Suite F
        Atlanta, GA 30336
        Attention: City Construction Manager

    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 City may require additional testing, repairs, or removal and replacement, at no additional cost to the City, of any or all manhole components provided for use in the City's sanitary sewer systems which were manufactured during a calendar week for which a concrete compressive strength test yields a result of less than 5,000 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.

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 manufacture 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 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.

O. All precast concrete manhole base sections and drop manhole bases shall be set on a foundation of #57 compacted stone aggregate, twelve (12) inch minimum thickness, and covering the entire bottom of the excavation for the manhole. Aggregate size may be adjusted by the Engineer based on field conditions.

P. Manhole steps shall conform to the requirements of this section.

2.2 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.

2.3 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 Vulcan Foundry, or as manufactured by the Griffin Foundry Co., Russell pipe & Foundry Co., or equal. Manhole covers shall be vented except those located within the one-hundred (100) year flood plain, within three (3) feet of curb for a two (2) lane road, or within the outside lane of a multi-lane road.

C. Sanitary sewer manhole covers shall have the words cast on the top in letters two (2) inches high per the City Standard Detail.

D. Manhole inlet steps shall be made of steel reinforced copolymer polypropylene model PS-1 PF. They shall be installed at maximum sixteen (16) inch intervals. Manhole steps shall be as shown in the Detail Drawings with rod and pull ratings meeting OSHA standards.

2.4 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 5,000 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 5,000 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 5,000 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 5,000 psi concrete containing type II cement with a C3A content of five and one-half (5½) percent or less.

2.5 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.

2.6 CONCRETE

Concrete shall conform to requirements of Section 03300.

2.7 MORTAR

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

3.1 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 Drawings.

3.2 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 Tylox Super Seal pre-lubricated gaskets 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 and at the locations shown on the Drawings. They shall be constructed of precast concrete sections as shown on the Drawings 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.

3.3 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.

3.4 MANHOLE TESTING

All manholes shall be vacuum tested in accordance with the requirements of Section 02650.

3.5 BACKFILL

The Contractor shall place and compact backfill materials, in the area of excavation surrounding manholes in accordance with the requirements of Section 02607.

3.6 CLEANUP

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.

END OF SECTION

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SECTION 02642

MANHOLE HEIGHT ADJUSTMENT

PART 1 - GENERAL

1.1 SCOPE

A. This section includes manhole entry and procedures for manhole height adjustment; 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 manhole height adjustment and related operations necessary or convenient to the Contractor for furnishing complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere:
   1. Section 01200 - Measurement and Payment
   2. Section 02643 - Manhole Frame and Cover Installation
   3. Section 02644 - Manhole Frame Sealing

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

A. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale).

B. ASTM A48/A48M - Standard Specification for gray iron castings.

PART 2 - PRODUCTS

2.1 BRICK

A. Brick 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	2¼	3 3/4	8
Allowable Variation	± 1/4	± 1/4	± 1/2

B. 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. 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.

2.2 MORTAR

A. The Contractor shall use mortar meeting the requirements of ASTM C270 Type S unless directed otherwise by the Engineer.

B. The Contractor shall prepare mortar only in quantities needed for immediate use. Mortar which has been mixed for more than thirty (30) minutes, which has set, or which has been retempered shall not be used.

PART 3 - EXECUTION

3.1 MANHOLE ENTRY

The Contractor shall exercise extreme caution during any manhole entry operations and shall adhere to all confined space entry requirements of OSHA. Particular attention shall be paid while working on larger diameter sewers. The Contractor shall implement all necessary safety precautions, in accordance with OSHA regulations, to give maximum protection at all times to persons or property at or near the site of the Work.

3.2 PROCEDURES FOR MANHOLE HEIGHT ADJUSTMENT

A. The Contractor shall utilize maps, surveys, sounding instruments, and/or information from City staff to determine approximate locations of buried manholes. Manholes shall be exposed utilizing hand techniques or by carefully probing with mechanical equipment. Manhole exposure in paved areas shall be accomplished by making a square cut in the surface with sufficient width to allow for the excavation of the material around the manhole to expose it to a depth necessary for adequate adjustment.

B. The Contractor shall adjust the top elevation of the manhole frame to grade where indicated on the Plans or directed by the Engineer using brick

and mortar conforming to the requirements of this section. A maximum adjustment of twelve (12) inches will be allowed using brick and mortar. Mortar shall be applied to create a smooth finish on the interior and exterior prior to backfill. Adjustments greater than twelve (12) inches shall be made by removing the cone section and adding the appropriate precast riser section.

C. When a manhole height adjustment is performed in a paved area and the manhole is not to be rehabilitated by any other method, then the Contractor shall install a manhole frame seal in accordance with the requirements of Section 02644.

END OF SECTION

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SECTION 02643

MANHOLE FRAME AND COVER INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section includes procedures for manhole frame and cover installation; 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 manhole frames and cover installations and related operations necessary or convenient to the Contractor for furnishing complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere:
1. Section 01200 - Measurement and Payment
2. Section 02642 - Manhole Height Adjustment

1.2 SUBMITTALS

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

The Contractor shall submit shop drawings of manhole frames and covers to the Engineer for approval before installation.

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

American Society for Testing and Materials (ASTM).

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall provide and install complete manhole covers and frames at each new sanitary sewer manhole, and in all other locations shown on the Plans or specified.

B. Manhole covers and frames shall conform to these specifications, the Drawings, all referenced standards, the requirements of the manhole manufacturer, and appropriate industry standards.

C. Manhole covers shall be of either Standard Type (non-bolted) or Bolt-Down Type, as indicated on the Plans or as otherwise specified. If not otherwise indicated, manhole covers shall be Standard Type.

D. The Contractor shall provide manhole covers and frames approved by the City.

2.2 MATERIALS

A. Manhole covers and frames shall be constructed of cast iron conforming to the requirements of ASTM A48-83 Class 30, as a minimum. Tensile strength of the cast iron shall be a minimum of 30,000 psi.

B. Covers and frames shall be "Heavy Duty" type, rated for a minimum of H-20 loading.

C. All castings shall be sound, smooth and clean, and free of blisters, pits, cracks, and other defects. Castings judged to be defective by the Engineer will be rejected, and shall be replaced by the Contractor at no additional cost to the City.

D. Casting tolerances shall be ± 1/16 -inch, with an additional one-sixteenth (1/16) inch per foot of dimension.

E. Manhole covers shall be cast with two (2) non-penetrating type pick-holes, located as indicated in the Detail Drawings. Pick-holes shall conform to the dimensions indicated in the Detail Drawings. 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.

F. Frames shall have integrally cast, full perimeter mud rings. Frames shall be cast with four (4), one (1) inch diameter holes in the flange for anchor bolts. Anchor bolt holes shall be located as shown in the Detail Drawings.

G. The seating surfaces of frames and covers shall be machined flat to ensure contact between the cover and frame along the full perimeter, in accordance with Federal Specifications RR-F-621.

H. Gaskets shall be provided and installed on all manhole frames. Gaskets shall be secured to the seating surface of the frame with a non-degrading glue by the manufacturer. Gaskets shall be flat, one-eighths (1/8) inch thick, black neoprene, with a tensile strength of 2,000 psi.

I. For manhole covers indicated as Bolt-Down Type, frames shall be cast and machined to accept four (4) cover bolts, on the pattern shown in the Detail Drawings. Covers shall be cast with four (4) holes, three-quarter (¾) inch diameter, for the bolts on the pattern shown in the Detail Drawings. Bolts shall be stainless steel, 5/8" - 1½ x 2" hex-head cap screws, and shall be provided with all bolt-down type covers. Bolts shall include stainless steel washers and rubber sealing gaskets.

J. Covers and frames shall bear lettering as illustrated in the Detail Drawings. No substitute cover designs will be accepted.

K. Covers shall be cast with four (4) stacking lugs, each five-eighths (5/8) inch wide by two (2) inches long, on the bottom of the lid.

L. Covers and frames shall conform to the following critical dimensions or as illustrated in the Drawings:

	Standard	Bolt-Down
Overall frame height	6 3/4 to 8"	6 3/4 to 8"
Cover diameter	23 ½"	23 ½"
Cover thickness, min.	1 3/8"	1 3/8"
Frame opening for cover	23 11/16"	23 3/4"
Frame opening for entry	22"	20 5/8"
Mud ring O.D.	25 7/8"	25 3/4"
Mud ring height, min.	3/4"	1 5/8"

PART 3 - EXECUTION

3.1 PROCEDURES FOR MANHOLE FRAME AND COVER INSTALLATION

A. The Contractor shall prepare the manhole top cone for frame installation per manhole and manhole cover manufacturer recommendations.

B. The Contractor shall prepare and install manhole frames and covers per manufacturer recommendations.

C. The Contractor shall check the installation of gaskets and replace all missing gaskets.

D. The Contractor shall install new frames and covers to the required elevations shown on the Plans or to the existing grade as directed by the Engineer.

E. The Contractor shall check the manhole covers for fit in the frame. If a manhole cover is either excessively loose or tight in the frame, or the cover rocks, wobbles, or otherwise moves in its frame, the frame and

cover shall be removed and replaced by the Contractor at no additional cost to the City.

F. The Contractor shall install and tighten stainless steel bolts on all Bolt-Down Type covers.

END OF SECTION

SECTION 02644

MANHOLE FRAME SEALING

PART 1 - GENERAL

1.1 SCOPE

A. This section includes the materials and methods for sealing leaking manhole frames for sanitary sewers; flexible rubber sleeve; flexible urethane resin; inspection; testing; cleanup; warranty; and any other similar, incidental, or appurtenant manhole frame sealing operation which may be necessary to properly complete the Work.

B. The Contractor shall provide all services, labor, materials, and equipment required for all manhole frame sealing 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 01200 - Measurement and Payment
2. Section 01550 - Traffic Regulations
3. Section 02642 - Manhole Height Adjustment

1.2 SUBMITTALS

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

A. The Contractor shall submit manufacturer's Certificate of Compliance certifying compliance with applicable specifications and standards.

B. The Contractor shall submit certified copies of test reports of factory tests required by the applicable standards and this section.

C. The Contractor shall submit manufacturer's installation instructions and procedures and insertion runs.

D. The Contractor shall submit procedures and materials for manhole frame sealing.

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

American Society for Testing and Materials (ASTM).

1.4 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for delivery, storage, and handling of products.

B. Products shall be kept safe from damage. Damaged products shall be removed from the site of the Work promptly. Damaged products shall be replaced with undamaged products.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials used for manhole frame sealing shall be pre-approved by the Engineer.

B. The installer shall warrant and hold harmless the City and the Engineer against all claims for patent infringement and any loss thereof.

C. The Contractor shall handle and store all materials and shall dispose of all wastes in accordance with applicable regulations.

D. All Work shall be performed in strict observance of OSHA regulations, especially those related to confined space entry.

E. The Contractor shall notify the City of Atlanta Fire Department and the City of Atlanta Department of Watershed Management and obtain approval and water meter, if required, before using fire hydrants.

2.2 FLEXIBLE RUBBER SLEEVE

A. Flexible rubber sleeve manhole frame seal shall be manufactured by Cretex Specialty Products. No other material shall be allowed.

B. The flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C923, with a minimum of 1500 psi tensile strength, maximum eighteen (18) percent compression set and a hardness (durometer) of 48 ± 5.

C. The flexible rubber sleeve shall be either double or triple pleated with a minimum unexpanded vertical height of 8 inches and 10 inches respectively and a minimum thickness of 3/16 inch. The top and bottom section of the flexible rubber sleeve shall contain an integrally formed expansion band recess and multiple sealing fins.

D. The top section of the extension shall have a minimum thickness of 3/32 inch and shall be shaped to fit into the bottom band recess of the flexible rubber sleeve under the bottom chimney seal band and the remainder of the extension shall have a minimum thickness of 3/16 inch. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the flexible rubber sleeve.

1. Any splice used to fabricate the flexible rubber sleeve and extension shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.
2. The continuous wedge strip used to adapt the flexible rubber sleeve to sloping surfaces shall have the slope differential needed to provide a vertical band recess surface, be shaped to fit into the band recess, and have an integral band restraint. The length of the wedge strip shall be such that, when its ends are butted together, it will cover the entire inside circumference of that band recess needing slope adjustment.

E. The expansion bands used to compress the sleeve against the manhole shall be integrally formed from 16 gauge stainless steel conforming to ASTM A240, Type 304, with no welded attachments and shall have a minimum width of 1 ¾ inches.

The bands shall have a minimum adjustment range of 2 diameter inches and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in this expanded position with a positive locking mechanism. Any studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-923 and 594, Type 304.

2.3 FLEXIBLE URETHANE RESIN

A. Flexible urethane resin manhole frame seal shall be Flex-Seal Utility Sealant as manufactured by Sealing Systems, Inc., unless otherwise specified. No other products will be allowed.

B. The flexible urethane resin manhole frame seal shall be used to form a flexible seal to stop inflow/infiltration and provide corrosion protection to the internal wall of a manhole from three (3) inches above the bottom of the frame to three (3) inches below the top of the cone. The finished product shall conform to the minimum requirements listed below:

	Prime Coat		Final Coat	
Hardness	ASTM-D 2240	85-90	ASTM-D 2240	75
Elongation	ASTM-D 442	400%	ASTM-D 412	800%
Tensile Strength	ASTM-D 412	3200 psi	ASTM-D 412	1150 psi
Adhesive Strength	ASTM-D 903	400 lb I/in	ASTM-D 903	175 lb I/in
Tear Resistance	ASTM-D 1004	210 lb I/in	ASTM-D 1004	755 lb I/in

PART 3 - EXECUTION

3.1 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 entering confined spaces.

B. Prior to entering manholes, an evaluation of the atmosphere will be conducted to determine the presence of toxic, flammable vapors, or possible lack of oxygen. The evaluation shall be in accordance with local, state, or federal safety regulations.

C. The Contractor shall provide traffic control in accordance with the requirements of Section 01550.

3.2 FLEXIBLE RUBBER SLEEVE

A. All manhole frames that are misaligned from the chimney or cone/corbel by three (3) inches or more shall be excavated and realigned. All existing frames shall be thoroughly cleaned before reinstallation.

B. All loose and protruding mortar and brick that would interfere with the seal's performance shall be removed and the appropriate areas of the manhole frame, chimney, and/or cone/corbel shall be cleaned by wire brushing. All sealing surfaces shall be reasonably smooth and circular, clean, and free of any loose material or excessive voids.

C. Detailed surface preparation, including providing a vertical surface on a cone when none exists, shall be in accordance with the frame seal manufacturer's instructions.

D. The Contractor shall install the flexible rubber sleeve in accordance with the manufacturer's instructions.

E. The Contractor shall field measure the manhole to determine the information required on the manufacturer's "Sizing and Ordering" procedure. This information is needed to obtain the proper size of bands, the size and shape of the rubber sleeve and the need for and size of any extensions.

F. The Contractor shall be properly trained, certified, and licensed in the installation of frame seals by the manufacturer and shall have a manufacturer's recommended expansion tool and all other equipment/tools necessary to install the frame seals.

3.3 INSPECTION

Manhole frame seals shall be visually inspected after installation to ensure that the seal is properly installed and that no voids or leakage points exist and that the manhole frame seal will not detach from the manhole. Any seals failing this visual test shall be reworked as necessary and retested at no additional cost to the City.

3.4 TESTING

Any seals not passing this visual inspection may, at the Contractor's expense, be tested for leakage using a method approved by the Engineer.

3.5 CLEANUP

After the installation work has been completed and all testing has been accepted, the Contractor shall clean up the entire Project area. All excess material and debris not incorporated into the permanent installation shall be disposed of by the Contractor. The work area shall be left in a condition equal to or better than prior condition. Disturbed grassed areas shall be seeded or sodded in accordance with Section 02933.

3.6 WARRANTY

The Contractor shall guarantee his work for a warranty period of five (5) years from the date of acceptance. If, at any time during the warranty period, any leakage, cracking, loss of bond, or other discontinuity is identified, the Contractor shall make repairs at no additional cost to the City.

END OF SECTION

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SECTION 02650
TESTING FOR ACCEPTANCE OF SANITARY AND STORM SEWERS

PART 1 - GENERAL

1.1 SCOPE

A. This section includes sanitary sewers inspection and testing methods; joint testing procedures; manhole testing methods; allowable testing limits for sanitary sewers; and any other similar, incidental, or appurtenant operation which may be necessary to properly complete the Work.

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 01200 - Measurement and Payment
2. Section 02535 - Gravity Flow Sanitary Sewers
3. Section 02537 - Ductile Iron Pipe Sanitary Sewer & Fitting
4. Section 02607 - Manholes, Junction Boxes, Catch Basins & Inlets
5. Section 02641 - Precast Concrete Manholes

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

American Standards for Testing and Materials (ASTM).

1.4 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 sewers.

1.5 TEST SECTIONS

A. Unless otherwise specified or directed by the Engineer, each section of sanitary sewer between manholes shall be tested by the air testing method. The Contractor will be permitted to install a maximum of 1200 feet of sewer prior to performing air testing.

B. The Contractor may at his option divide the first section of sewer into subsections of more convenient length for testing. If the section or subsection tested does not pass the tests, it shall be repaired and the test repeated until a satisfactory test is obtained. Excavation shall not proceed beyond the first 1200-foot section until test results for the entire 1200 feet are satisfactory.

C. The Engineer may allow alternate testing methods at his discretion or require additional testing methods if, in his opinion, they are warranted.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.1 SANITARY AND STORM SEWERS INSPECTION AND TESTING METHODS

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 clean and test lines before requesting final acceptance. Where any obstruction is met, the Contractor shall clean the sewers by means of rods, swabs, or other instruments. When requested by the Engineer, the Contractor shall flush out lines and manholes before final inspection.

C. Alignment: Pipe lines shall be straight and show a uniform grade between manholes, except for curves specifically shown on the Plans. The Contractor shall correct any discrepancies discovered during inspection.

D. Watertightness: All sewers constructed shall be tested for watertightness to the maximum extent feasible. Infiltration and exfiltration tests shall be performed on all new sewers constructed as specified in this section, except for those new sewers constructed which have active services tied into them as the pipe is being installed. In such cases the watertightness of the sewers less than or equal to thirty-six (36) inches shall be based on a visual inspection, and for sewers forty-two (42) inches and larger based on the individual joint test as specified in this section. All visible leaks, including those found via television inspection, shall be repaired.

E. Infiltration Tests:
   1. The Contractor shall install suitable weirs in manholes selected by the Engineer to determine the leakage of ground water into the sewer. The maximum length of line for each infiltration test shall be five-thousand (5,000) feet. The Contractor shall install weirs for a minimum of four hours before measuring flow. If leakage in any section of the sewer line exceeds fifty (50) gpd/inch diameter/mile, the Contractor shall locate and repair leaks. Repair methods must be approved by the Engineer. After repairs are completed, the Contractor shall re-test for leakage. Infiltration testing shall be performed before sanitary sewer lateral reconnections are made.
   2. The Contractor shall furnish, install, and remove the necessary weirs, plugs, and bulkheads required to perform the leakage tests.
   3. Weirs shall be V-notch type equal to Pollard (800/437-1146).

F. Exfiltration Tests:
   1. 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 or in short sections (twenty-five [25] feet or less) using inflatable balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer section until internal air pressure reaches approximately four (4) psi. After this pressure is reached and the pressure allowed to stabilize (approximately two (2) to five (5) minutes), the pressure may be reduced to three and one-half (3.5) psi before starting the test. If the pressure drop is equal to or less than one (1) psi during the test time, then the line will be considered as having passed the test. If the pressure drops more than one (1) psi during the test time, the line will be presumed to have failed the test, and the Contractor shall be required to locate the failure, make necessary repairs, and retest the line. Minimum test time for various pipe sizes and types is as follows:

Nominal Pipe Size, inches	Time (Min/100 feet)	
	VCP, RCP	DIP, PVC
6	0.7	5.7
8	1.2	7.6
10	1.5	9.4
12	1.8	11.3
15	2.1	14.2
18	2.4	17.0
21	3.0	19.8
24	3.6	22.8
30	*	35.4
36	*	51.2

* For pipe diameters greater than 24 inch check with manufacturer

b. Required test equipment, including inflatable balls, braces, air hose, air source, time, rotameter as applicable, cut-off valves, pressure reducing valve, 0-15 psi pressure gauge, 0-5 psi pressure gauge with gradations in 0.1 psi and accuracy of ± two (2) percent, shall be provided by the Contractor. Testing equipment shall be equal to Cherne Air-Loc Testing Systems.

c. The Contractor shall keep records of all tests made. Copies of such records shall be given to the Engineer or the City. Such records shall show date, line number and stations, operator, and such other pertinent information as required

by the Engineer.

d. The Contractor is cautioned to observe proper safety precautions in the performance of the air testing. It is imperative that plugs be properly secured and that care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over-pressurizing the sewer line.

2. 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.

G. Smoke Testing: Smoke testing may be used only to locate leaks and in no case shall be considered conclusive or a substitute for air tests, exfiltration tests, or infiltration tests. In all cases a smoke test shall be accompanied by an air test, exfiltration test, or infiltration test. The Engineer may order a smoke test if another leakage test fails and the source of the leak cannot be determined by other means. Smoke testing may only be performed where ground water is low. Smoke shall be blown into a sealed section of sewer under pressure and the Contractor and Engineer shall observe for any smoke appearing on top of the ground indicating the presence of leaks. The Engineer may require that the Contractor excavate the sewer to determine the source of any smoke appearing during the smoke test. All leaks or breaks discovered by the smoke tests shall be repaired and/or corrected by the Contractor at his own expense in a manner acceptable to the Engineer. Equipment and supplies required for smoke tests shall be furnished by the Contractor. The Contractor may perform smoke tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

H. Dye Testing: Dye testing may be used only to confirm service connection or disconnection and in no case shall be considered conclusive or a substitute for air tests, exfiltration tests, or infiltration tests. Dye testing may only be performed where ground water is low. Dye shall be introduced into the service lateral and the Contractor and Engineer shall observe for any dye appearing on combined or sanitary sewers. Equipment and supplies required for dye tests shall be furnished by the Contractor. The Contractor may conduct dye tests at any time during construction at his option; however, any such tests shall not supplant the final test of the completed work.

I. 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 Engineer, and shall have sufficient rigidity so the legs of the mandrel will not deform when pulling through a pipe. The Contractor shall provide a proving ring for each size mandrel, with a tolerance of no more than 0.02 inch clearance, and the mandrel dimensions shall be checked by the Engineer, using this proving ring, before use by the Contractor.
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.

J. Closed Circuit Television Inspection: The Engineer may require that the interior of a new gravity sewer be subjected to a televised inspection. Prior to Final Acceptance the City shall be provided with one copy of the TV inspection report and CD-ROMs showing the entire length of the gravity sewer tested. The report shall contain the condition of pipe, type of pipe, depth, location of services, length, type of joints, roundness, and distance between manholes. Any pipe found to be cracked, leaking, misaligned, bellied, or otherwise defective shall be removed and replaced.

3.2 JOINT TESTING PROCEDURES

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 will have failed the test. After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure drops by more than two (2) psi

within fifteen (15) seconds, the joint will have failed the test.

1. All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation by the Engineer. The void pressure data shall be transmitted electronically from the void to the monitoring equipment.
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 Engineer. The demonstration test may be required, by the Engineer, 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 Engineer who will 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.

B. Lamping Procedures: Lamping will be performed on all sewer pipeline by the Engineer.

3.3 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 watertightness, all liftholes shall be plugged with a non-shrink grout, all joints between precast sections shall be properly sealed and all pipe openings shall be temporarily plugged and properly braced.
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 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	
Depth (feet)	Diameter, feet

	Test Time, seconds		
	4	5	6
8	20	28	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

C. The City reserves the right to have third party consultants perform construction materials testing and assessments to any new manhole.

3.4 ALLOWABLE TESTING LIMITS FOR SANITARY SEWERS

A. No Infiltration and exfiltration of ground water or other leakage into or out of the sewer shall be allowed during the twenty-four (24) hour test period.

B. Any visible or audible leaks into the sewer that can be located shall be repaired or corrected as directed by the Engineer.

C. Air leakage tests shall be performed in accordance with the requirements of ASTM C828.

+++END OF SECTION+++

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SECTION 02668
WATER SERVICE CONNECTIONS

PART I - GENERAL

1.1 SCOPE

A. The work covered by this Section includes furnishing all materials and equipment, providing all required labor, installing water service connections and all appurtenant work according to these Specifications and/or to the Water Connection Detail as shown schematically on the Drawings.

B. Water meters are not to be furnished nor installed. However, the water meter connection must be compatible with the water meters currently used by the Owner.

C. No galvanized pipe or fittings shall be used on water service connections.

1.2 LOCATIONS

Locations shall be as directed by the Engineer along the route of the water mains.

1.3 SERVICE COMPATIBILITY

It is the intent of these Specifications that the water service connections shall duplicate those presently being provided by the Owner in order to be compatible with their service maintenance procedures.

1.4 QUALITY CONTROL

All materials installed under this Section shall have the approval of the NSF for water services (NSF 61).

PART 2 - PRODUCTS

2.1 MATERIALS AND CONSTRUCTION

A. Service Line

Copper Tubing: Tubing shall be ASTM B 88, Type K, rolled type. Fittings shall be brass with flare connection inlets and outlets, ANSI B16.26. Where required, adapters shall be brass. Unions shall be cast bronze. Joints shall be flare type. All fittings shall be of bronze

construction with flare type connections.

B. Meter Boxes

1. Meter boxes shall be cast iron painted black with a locking lid quad valve box. Meter boxes shall have nominal dimensions of 14-3/4 inches x 17 inches at bottom, 12 inches x 14 inches opening, and 12 inches tall. Meter box assemblies shall include one U-branch, four ball valves, two unions, two touch plugs with cotter pins, and two expansion connections. The entire assembly shall be configured to allow 7-1/2 inch meter and an ASSE 1024 dual check valve with a combined distance of 12-3/4 inches between inlet and outlet unions for the installation of the meter and ASSE 1024 dual check valve backflow preventer. The owner will install the meter for domestic use or irrigation use after property owner applies for it.

2. Meter boxes shall be equal to Ford Meter Box Company, Double Gulf Box Part #LDG12U-243FULTTPNA (formerly Part #LDG12U-243-NA-TT).

C. Valves and Accessories

1. Ball valves shall be full port bronze, heavy duty type. Valve ends shall be threaded. Valves shall have a minimum 200 psi working pressure for water. Valves shall have stainless steel nut and handle. Valves shall be made in the U.S.A.

2. Corporation Cocks

a. Corporation cocks shall be ground key type, shall be made of bronze conforming to ASTM B61 or B62 and shall be suitable for the working pressure of the system. Ends shall be suitable for flare type joint. Coupling nut for connection to flared copper tubing shall conform to ANSI B16.26.

b. Corporation cocks shall be equal to Ford FB-600-4.

PART 3 - EXECUTION

3.1 GENERAL

A. Installation shall conform to the details for water service connections appearing schematically on the Drawings. Contractor shall provide any and all appurtenant work required to provide the intended water service connections.

B. The Contractor shall be prepared to make emergency repairs to the water system, if necessary, due to damage by others working in the area. In conjunction with this requirement, the Contractor shall furnish and have available at all times, a tapping machine, for the purpose of making temporary water service taps or emergency repairs to damaged water services. The Contractor shall furnish the Owner a phone number of an individual with the authority to initiate emergency repair work. This number must be provided prior to starting work on the Project.

3.2 TAPPING MAIN

A. All services connected to water main shall be through a 1-inch direct tap, regardless of service and meter size.

B. The water main shall be tapped with a tapping machine specifically designed for that purpose. The tap shall be a direct tap into the water main through a 1-inch brass corporation cock. All taps shall be supervised by the owner. All taps shall be made on the water main at a position so as not to be the top side of the pipe nor the bottom of the pipe. Distance between taps must be a minimum of 12-inches apart.

3.3 SERVICE LINES

A. Copper tubing between tap and water meter shall be one continuous length of pipe with no intermediate joints or connections. The service line shall be placed without sharp turns or bends from the water main to the meter box.

B. When meters are located on the opposite side of the street from the water main, new copper service lines shall be extended through a common 6-inch bore, Schedule 40 PVC conduit to the service side. Replacement of existing services may be by free bore without a casing.

C. Provide detection tape over all service lines.

3.4 METER BOXES

A. The meter box shall be located parallel to the curb and centered within the space two feet behind the back of the curb. The meter box lid shall be set at finished grade of the road shoulder. The meter box shall be placed on a bed of gravel or crushed stone. The bed shall be 3-inches thick and extend 6-inches in all directions beyond the edge of the meter box. The box shall be carefully and uniformly backfilled to prevent distortion that would cause leaks. Meter boxes shall be located in pairs within two feet of the common property lines between

the lots.

B. All water meters shall have fluorescent markings at curb. Markings shall not be the same color as markings denoting hydrants.

C. An 8-inch long threaded brass nipple shall be provided between the meter and a ball valve on the residence side of the meter box. The ball valve shall be located in an 8-inch diameter fiberglass valve box with lid. The valve box shall be placed on a blanket of granular crushed stone. The bed shall be 3-inches thick and extend 3-inches in all directions beyond the edge of the valve box.

3.5 RELOCATION OF SERVICE LINES

Existing service lines shall be field-located by the Contractor. The Contractor shall be responsible for locating existing water meters, relocating the meters and meter boxes as necessary, and determining the existing size service line to reconnect the meters to the new water mains. All service lines installed under existing pavement, including streets, driveways and sidewalks, shall be installed by boring.

3.6 TRANSFER OF SERVICE

Immediately before connecting to the relocated or existing meter, all service lines shall be flushed to remove any foreign matter. Any special fittings required to reconnect the existing meter to the new copper service line, or the existing private service line, shall be provided by the Contractor. To minimize out of service time, the Contractor shall determine the connections to be made and have all the required pipe and fittings on hand before shutting off the existing service. After completing the connection, the new corporation stop shall be opened and all visible leaks shall be repaired.

END OF SECTION

SECTION 02711
CHAIN LINK FENCE AND GATES

PART 1 GENERAL

1.1 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 types indicated as follows:

1. Zinc-coated steel fence fabric with galvanized steel posts, rails, caps, hardware and fittings.

2. Polyvinylchloride (PVC) coated steel fence fabric with vinyl coated and factory- painted steel posts, rails, caps, hardware and fittings in a color to be determined by the Owner.

B. Fencing and gates shall be installed in the locations as shown on the Drawings or as directed by the Engineer, 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.

1.2 SUBMITTALS

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

A. Manufacturer’s product data.

B. Detailed shop drawings of the fence and gate layout, including installation details of the fencing, posts, gates, hardware and accessories.

C. If PVC coated fencing is indicated or specified, manufacturer’s color chart of available colors and physical sample of the selected color.

1.3 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.

1.4 TRANSPORTATION AND HANDLING

Provide transportation and handling in accordance with the requirements of Section 01610 of these Specifications.

1.5 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 F668 – Standard Specification for PolyvinylChloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric

13. ASTM F900 – Standard Specification for Industrial and Commercial Swing Gates

14. ASTM F934 – Standard Specification for Standard Colors for Polymer-Coated Chain-Link Fence Materials

15. ASTM F1083 – Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

16. ASTM F1664 – Standard Specification for PolyvinylChloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence

17. ASTM F1665 – Standard Specification for PolyVinylChloride (PVC) and Other Conforming Organic Polymer-Coated Steel Barbed Wire Used with Chain-Link Fence

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)

PART 2 PRODUCTS

2.1 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 as shown on the Drawings.

2.2 MATERIALS

A. Chain Link Fence Fabric

1. Zinc Coated Steel Fence Fabric: Fabric shall be 9 gage wire, woven to 2-inch squares and shall be galvanized in accordance with ASTM A392, Class 2.

2. PVC Coated Steel Fence Fabric

   a. Fabric shall be 9 gage wire, woven to 2-inch squares.
   b. Fabric shall be PVC coated in accordance with ASTM F 668.
   c. Color shall be selected by the Owner from manufacturer's standard colors as specified in ASTM F934.

3. 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 2.875-inches outside diameter galvanized pipe weighing not less than 5.79 pounds per linear foot for end, corner and gate posts for gates 6-feet wide and smaller. Gate posts for gate leaves from 6-feet to 13-feet shall have an outside diameter of 4.00-inches, weighing not less than 9.11 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. Pipe Framework for PVC Coated Fabric

1. Posts and rails shall be vinyl-clad steel with color coated polyvinylchloride chemically bonded to standard weight ASTM F1083 galvanized steel pipe by electrostatically applied powder coating process. Protective vinyl coating thickness shall be 10 to 14 mils.

2. Color shall match fence fabric color.

D. Tension Wire: Tension wire for top and bottom edge support of fence fabric shall be No. 7 gage steel zinc-coated wire conforming to ASTM A824 with a minimum tensile strength of 80,000 psi. For PVC coated fabric, provide tension wire coated with PVC, conforming to ASTM F1664. PVC coating shall match fence fabric in color.

E. 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, and PVC coated by the thermal-fusion-bond process in color matching posts for PVC coated 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.

F. 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.

G. 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.

H. 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.

I. 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.

2. Accessories for PVC fencing shall be vinyl coated or painted to match color of fence fabric.

J. 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.

4. Extension arms for PVC coated fencing shall be vinyl-coated or painted to match color of fence fabric.

K. Barbed Wire: Barbed wire shall be double strand 12 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). For PVC coated fabric, provide barbed wire coated with PVC conforming to ASTM F1665. PVC coating shall match fence fabric in color.

L. 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.

d. For PVC coated fencing, gate components shall be PVC coated or painted in color matching fence fabric.

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.

M. 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.

2.3 GROUND RODS

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.

2.4 CONCRETE AND GROUT

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

3.1 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.

3.2 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.

3.3 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

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SECTION 02730
SEWERS AND ACCESSORIES

PART 1- GENERAL

1.1 SCOPE

A. The Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all sewers and accessories. All sewers and accessories shall be installed, adjusted, tested and placed in operation in accordance with these Specifications and the manufacturer's recommendations and as shown on the Drawings.

B. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. Latest revisions of all standards are applicable.

1.2 QUALIFICATIONS

If requested by the Engineer, submit evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two years.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. 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.

C. The Contractor shall submit manufacturers' instructions indicating special procedures required to install products specified.

D. Submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings adapters, valves and specials along with the manufacturer's drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, station limits, and transition stations for various pipe classes. The above shall be submitted to the Engineer for review before fabrication and shipment of these items. The locations of all pipes shall conform to the locations indicated on the Drawings.

1.4 TRANSPORTATION AND HANDLING

A. Unloading: 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. Handling: Handle pipe, fittings, valves 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.

C. Lined pipe shall be handled and transported to prevent damage to linings.

1.5 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 pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times. Valves shall be drained and stored in a manner that will protect them from damage by freezing.

C. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tier shall be kept off the ground on timbers, rails or concrete. Pipe in tiers shall be alternated: bell, plain end; bell, plain end. At least two rows of timbers shall be placed between tiers and chocks, affixed to each other in order to prevent movement. The timbers shall be large enough to prevent contact between the pipe in adjacent tiers.

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.

1.6 QUALITY ASSURANCE

A. Product manufacturers shall provide the Engineer with written certification that all products furnished comply with all applicable provisions of these Specifications. All materials which fail to conform to these Specifications shall be rejected.

B. If ordered by the Engineer, each pipe manufacturer shall furnish the

services of a competent factory representative to supervise and/or inspect the installation of pipe. This service will be furnished for a minimum of five days during initial pipe installation.

C. After delivery to the site, any materials which have been damaged in transit or are unsuitable for use in the work shall be rejected and removed from the site.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

A. Ductile iron pipe shall be manufactured in accordance with AWWA C151. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings. All pipe shall have a minimum pressure rating as indicated in the following table, and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

Pipe Sizes (inches)	Pressure Class (psi)
4 - 12	350
14 - 18	350
20	300
24	250
30 - 54	200
60 - 64	200

B. Flanged pipe minimum wall thickness shall be equal to Special Class 53. Flanges shall be furnished by the pipe manufacturer.

C. Pipe shall be cement lined in accordance with AWWA C104. Pipe shall be furnished with a bituminous outside coating.

D. Fittings shall be ductile iron and shall conform to AWWA C110 or AWWA C153 with a minimum rated working pressure of 250 psi. Fittings shall be cement lined in accordance with AWWA C104 and shall be furnished with a bituminous outside coating. In lieu of cement lining and bituminous coating, fittings may be provided with a fusion bonded coating and lining meeting the requirements of AWWA C116.

E. Joints:

1. Unless shown or specified otherwise, joints shall be push-on or restrained joint type for pipe and standard mechanical, push-on or restrained joints for fittings. Push-on and mechanical joints shall conform to AWWA C111.

2. Restrained joints: Restrained joints shall be manufactured restrained joint or restraining gasket joint as specified below.

   a. Manufactured restrained joints shall be American, FLEX-RING or LOK-RING, U.S. Pipe TR FLEX or HP LOK, or Clow SUPER-LOCK.

   b. Restraining gasket joints shall be assembled with American Fast-Grip gaskets or US Pipe FIELD LOK gasket.

   c. Retainer glands on a mechanical joint may be used as a restrained joint only where retainer glands are specifically shown on the drawings or where specifically specified.

   d. Where retainer glands are allowed, in lieu of retainer glands specified elsewhere, the joint may be assembled with US Pipe MJ FIELD LOK gasket.

   e. No field welding for manufactured restrained joint pipe assembly will be permitted. Where field cutting of restrained joint pipe is required, the joint may be assembled with American Field Flex-Rings or US Pipe TR FLEX GRIPPER Rings.

3. Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

4. Provide the appropriate gaskets for mechanical and flange joints. Gaskets for flange joints shall be made of 1/8-inch thick, cloth reinforced rubber or as recommended by the manufacturer to accommodate the pipe pressure class; gaskets may be ring type or full face type.

5. Bolts and Nuts

   a. 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.

   b. Bolts and nuts for mechanical joints shall be Tee Head Bolts and

nuts of high strength low-alloy steel in accordance with ASTM A 242 to the dimensions shown in AWWA C111/ANSI A21.11.

c. 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.

d. Bolts for exposed service shall be zinc plated, cold pressed, 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.

e. Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A 193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A 194, Grade 8.

6. Mechanical joint glands shall be ductile iron.

F. Flexible, restrained joint pipe shall be minimum Class 54. Joints shall be ball and socket type providing restraint and leak-tight connections for up to 15 degrees of joint deflection. Flexible, restrained joint pipe shall be equal to American "FLEX-LOK", U.S. Pipe "USIFLEX", or Clow F-141. Appropriate transition pieces shall be utilized on each end of run of flexible joint pipe. All joint material required for proper installation shall be furnished by the pipe manufacturer.

G. Restrained joint pipe (RJP) on supports shall have bolted joints and shall be specifically designed for clear spans of at least 36 feet.

H. Polyethylene film used to provide polyethylene encasement shall be tubular and shall meet the requirements of AWWA C105.

I. Pipe outlets shall be welded-on ductile iron pipe. Outlets shall be plain end, push-on, mechanical, or flanged joint. All welding, fabrication and outlet hole drilling shall be performed by the manufacturer. Outlets shall be free of burrs. Sizes shall be as indicated on the Drawings. The outlets and parent pipe shall be minimum Class 53 ductile iron pipe for parent pipe 54-inches and smaller. For pipe larger than 54-inches, parent pipe shall be Pressure Class 350.

J. Thrust collars shall be welded-on ductile iron body type designed to withstand thrust due to 250 psi internal pressure on a dead end.

K. Acceptance will be on the basis of the Engineer's inspection and the

manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

L. 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.

M. Ceramic Epoxy Lining (all pipe diameters)

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:

1. 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.

a. 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.

iv. 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.

2.2 POLYVINYL CHLORIDE (PVC) PIPE

A. Polyvinyl chloride pressure pipe shall be as specified in Part 2 of Section 15060 of these Specifications.

B. Polyvinyl Chloride Pipe (AWWA C900)

1. All PVC pipe shall have belled ends for push-on type jointing and shall conform to ANSI/AWWA C900, ductile iron pipe equivalent outside diameters. The pipe shall have a Dimension Ratio (DR) of 18 and shall be capable of withstanding a working pressure of 200 psi. Pipe shall be supplied in minimum lengths of 20 feet.

2. All fittings shall be of cast or ductile iron meeting the requirements

of AWWA C153/ANSI A21.53 with a minimum rated working pressure of 250 psi. Fittings shall be cement lined in accordance with AWWA C104/ANSI A21.4. Fittings shall be furnished with a bituminous outside coating.

3. Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the National Sanitation Foundation (NSF) applicable standards. Additionally, each piece of pipe shall be stamped "NSF Approved".

C. Schedule PVC Pipe, Less Than 4-Inch Diameter

1. Schedule 80, ASTM D 1784 and ASTM D 1785

2. Fittings: Solvent weld socket type, same schedule as piping, ASTM D 2466 or D 2467

3. Solvent Cement: ASTM D 2564

D. Detection Tape: Provide detection tape over all PVC sewers.

2.3 HIGH DENSITY POLYETHYLENE PIPE – SANITARY SEWER (HDPE)

A. HDPE gravity sewer pipe shall be supplied in lengths not longer than 13 feet and shall be "Spirolite", manufactured by Chevron Spirolite Corporation.

B. Pipe and Fittings: High-density polyethylene (HDPE) gravity sewer pipe and fittings shall be manufactured in accordance with ASTM F 894. All fittings shall be factory fabricated. No field fabrication of fittings will be permitted. HDPE pipe shall be RSC Class 100.

C. Joints: Joints for pipe and fittings shall be of the bell and spigot type with a confined gasket meeting the requirements of ASTM D 3212. The gasket shall comply with the physical non-pressure requirements of ASTM F 477.

D. Detection Tape: Provide detection tape over all HDPE sewers.

E. Manhole Connections: Provide manhole entry pieces consisting of a 3-foot section of pipe, approximately, with a smooth surface area at one end and a standard bell or spigot at the other.

F. Acceptance: Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2.4 HIGH DENSITY POLYETHYLENE PIPE – STORM SEWER (HDPE)

A. HDPE gravity flow storm sewer drainage (4" diameter to 60" diameter) pipe shall be supplied in lengths not longer than 20 feet and shall be "N-12 ST IB", manufactured by an Advanced Drainage Systems, Inc.

The pipe requirements shall be as follows:

1. For pipes 4- through 60-inches (100 to 1500 mm) diameters, the pipe shall have smooth interiors and annular exterior corrugations and shall meet or exceed the requirements of ASTM F2648.

B. Pipe and Fittings: HDPE gravity storm sewer pipe and fittings shall be manufactured in accordance with ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of ASTM F2306. All fittings shall be factory fabricated. No field fabrication of fittings will be permitted.

C. Joints: Pipe shall be joined using a bell & spigot joint meeting ASTM F2648. The joint shall be soil-tight and gaskets for diameters 12- through 60-inch, shall meet the requirements of ASTM F477. For diameters 4- through 10- inch, the joint shall be soil-tight using an engaging dimple connection. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.

D. Detection Tape: Provide detection tape over all storm sewer HDPE.

E. Manhole Connections: Provide manhole entry pieces consisting of a 3-foot section of pipe, approximately, with a smooth surface area at one end and a standard bell or spigot at the other.

F. Acceptance: Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2.5 MANHOLES AND PRECAST CONCRETE PRODUCTS

A. Precast Concrete Sections

1. Precast concrete sections shall meet the requirements of ASTM C 478. The minimum compressive strength of the concrete in precast sections shall be 4,000 psi.

2. The minimum wall thickness shall be one-twelfth of the inside diameter of the base, riser or the largest cone diameter or as shown on the Drawings. Additionally, the wall thickness shall be sufficient for the proper installation of the rubber boots.

3. Transition slabs which convert bases larger than four feet in diameter to four-foot diameter risers shall be designed by the manhole manufacturer to carry the live and dead loads exerted on the slab.

4. Seal joints between precast sections by means of rubber O-ring gaskets or flexible butyl rubber sealant. Butyl rubber sealants shall meet the requirements of AASHTO M-198. Sealant shall be pre-formed type with a minimum nominal diameter of 1-inch. Butyl rubber sealant shall be equal to Kent Seal No. 2 or Concrete Sealants CS202.

B. Brick and Mortar: Brick shall be whole and hard-burned, conforming to ASTM C 32 Grade MS. Mortar shall be made of one-part Portland cement and two parts clean sharp sand. Cement shall be Type 1 and shall conform to ASTM C 150. Sand shall meet ASTM C 144.

C. Pipe Tee Manholes: Concrete pipe tees shall meet the requirements of the pipe in which it is used. Steel reinforcement in the riser shall be securely welded to steel in line pipe before concrete fill is begun. The remainder of the manhole shall be as specified for precast concrete sections.

D. Iron Castings

1. Cast iron manhole frames, covers and steps shall meet the requirements of ASTM A 48 for Class 30 gray iron and all applicable local standards. All castings shall be tough, close grained, smooth and free from blow holes, blisters, shrinkage, strains, cracks, cold shots and other imperfections. No casting will be accepted which weighs less than 95 percent of the design weight. Shop drawings must indicate the design weight and provide sufficient dimensions to permit checking. All castings shall be thoroughly cleaned in the shop and given two coats of approved bituminous paint before rusting begins.

2. Manhole frames and covers shall be City of Atlanta standard.

Type	Design	Manufacturer's Reference

	Weight		
Standard	270#	Neenah R-1695	Vulcan V-1349
Traffic	400#	Neenah R-1642	Vulcan V-1349
Watertight	400#	Neenah R-1916-F1	Vulcan V-2358

3. All frames and covers shall have machined horizontal bearing surfaces.

4. All manholes shall have standard frames and covers except where specifically shown otherwise on the Drawings.

5. Watertight covers shall be bolt-down type and shall be equipped with four 1/2-inch stainless steel bolts and a 1/8-inch red rubber or rubber O-ring gasket. Covers shall be rotatable and interchangeable. Bolt holes shall be bored through so that debris entering the bolt hole will fall into the manhole. Bolt holes shall have the full 360-degree circle within the cover's radius when bored through the cover.

E. Plastic Steps: Manhole steps of polypropylene molded around a steel rod equal to products of M.A. Industries may be used.

F. Rubber Boots: Provide preformed rubber boots and fasteners equal to those manufactured by Kor-N-Seal or Press Seal Gasket Corporation.

2.6 MISCELLANEOUS ACCESSORIES

A. Flexible Adapter Couplings

1. Couplings for pipe sizes 15-inches in diameter and less shall be elastomeric plastic sleeves designed to connect pipes of dissimilar materials. Adapters shall provide a positive seal against infiltration and exfiltration and remain leakproof and rootproof up to 4.3 psi. The adapter manufacturer shall provide all stainless-steel clamps and required accessories.

2. Couplings shall be products of Fernco and shall be installed in accordance with the manufacturer's recommendations.

B. Flexible Adapter Donuts

1. Adapter donuts shall be elastomeric polyvinyl chloride (PVC), compressible seals designed for sealing joints between sewer pipes of different sizes and/or dissimilar materials. Adapters shall provide a positive seal against infiltration and exfiltration and remain leakproof and rootproof up to 4.3 psi.

2. Donuts shall be products of Fernco and shall be installed in accordance with the manufacturer's recommendations.

C. Detection Tape: Detection tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Tapes shall be color coded in accordance with APWA color codes with the following legends: Sanitary Sewerage Systems, Safety Green, "Caution: Sewer Line Buried Below". Colors may be solid or striped. Tape shall be permanently printed with no surface printing allowed. Tape width shall be minimum 2-inches when buried less than 10-inches below the surface. Tape width shall be minimum 3-inches when buried greater than 10-inches and less than 20-inches. Detection tape shall be equal to Lineguard Type III Detectable or Allen Systems Detectatape.

D. Anchor Couplings: Lengths and sizes shall be as shown on the Drawings. Anchor couplings shall be equal to Tyler Pipe 5-198.

E. Flange Adapter: Flange adapters shall permit the connection of unthreaded, ungrooved, open-ended, ductile iron pipe to ANSI/ASME B16.1, Class 125 flanges. Flange adapters shall meet the test requirements of ANSI/ASME B16.1 for Class 125 flanges. The adapter shall be a ductile iron casting incorporating a flange with extended throat, set screws and gasket. The gasket shall provide a compression seal between the adapter, the pipe and the adjacent flange. Flange adapters are to be used only in locations specifically shown on the Drawings [or at the direction of the Engineer,] and in accordance with the manufacturer's recommendations. Flange adapters shall be equal to EBAA Iron "Mega Flange".

F. Retainer Glands

1. Retainer glands for ductile iron pipe shall be Megalug Series 1100, as manufactured by EBAA Iron, Uni-Flange Series 1400, as manufactured by Ford Meter Box Company, or Star Pipe Products Star-Grip Series 3000.

2. Retainer glands for PVC pipe shall be Megalug, Series 2000PV as manufactured by EBAA Iron, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall control traffic in accordance with the requirements of Section 01550 - Traffic Regulation.

B. 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.

C. 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.

D. 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.

E. The Contractor shall install and operate a dewatering system in accordance with the requirements of Section 02140 - Dewatering.

F. Where wastewater flow diversion is required for the performance of the Work, the Contractor shall provide wastewater flow diversion in accordance with the requirements of Section 02600 - Wastewater Flow Control.

3.2 PIPE LAYING

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 his available pumping facilities are able to dewater. Movement of water that would tend to erode or affect the trench walls will not be allowed.

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.

3.3 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 and Storm Sewers. All pipe in place shall be carefully protected from damage until the backfilling operations have been completed. Any pipe which has been disturbed after jointing shall be removed, the joint cleaned and remade and the pipe re-laid at the Contractor's expense.

3.4 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.

3.5 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 the Contract Documents and compacted to the equivalent density of the surrounding undisturbed material.

3.6 HOUSE SEWERS AND MULTIPLE DWELLING SEWERS

A. Stubouts for house service lines and multiple dwelling service lines shall be installed when stipulated in the Special Conditions or shown on the Plans. However, additional connections shall be installed by the Contractor when directed by the Engineer.

B. House service lines for single dwelling units shall consist of six (6) inch diameter sewer pipes, and service lines for multiple dwelling units served by a single line shall consist of eight (8) inch diameter sewer pipes, constructed as specified in this section. If the plumbing code in effect at the time of construction specifies larger pipe or if the existing house service line is larger than the specified diameters, then the larger pipe shall be installed. House service line stubouts for vacant lots shall be installed at the locations shown on the Plans or designated by the Engineer to provide a service line from the tee in the sewer. House service line stubouts shall be installed in accordance with the Detail Drawings. The open end of such stubouts shall be closed with approved stoppers and properly restrained.

C. Cleanouts shall be installed for each continuous run of one hundred (100) feet and at each change in horizontal or vertical direction. Cleanouts shall be constructed in accordance with the Detail Drawings. Cleanouts shall be plugged with approved stoppers. Stoppers shall be properly restrained.

D. Backfilling for service lines shall commence immediately upon acceptance by the Engineer. Backfill materials shall be as specified in the Contract Documents and shall be compacted to the equivalent density of the surrounding undisturbed material.

3.7 CONNECTING EXISTING SANITARY SEWERS TO NEW SANITARY SEWERS

A. All existing separate sanitary sewers shall be connected to new separate sanitary sewers as shown on the Plans or as directed by the Engineer. Connections shall be made by the construction of a manhole or utilization of an existing manhole.

B. Connection of lateral collector sewers to large diameter trunk sewers shall be made at existing manholes or new manholes.

C. Connections to existing manholes shall be made by coring a hole in the wall of the existing manhole, installing a boot, inserting the same pipe material as the mainline being constructed, filling around same with non-shrinking grout and troweling the inside and outside surfaces of the joint to a neat finish.

D. Connections of existing separate sanitary sewers to new separate sanitary sewers shall be plugged and shall remain plugged until final acceptance by the Engineer.

3.8 TOLERANCES

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:

A. If the sewer is laid at negative grade, the Contractor shall remove and reinstall the sewer at the correct grade at no additional cost to the City.

B. If the sewer is laid at a grade less than that shown on the Plans, thus reducing the sewer's capacity, the City may require the sewer to be removed and relaid at the correct grade at no additional cost to the City. As a minimum, the grade to the next upstream manhole shall be adjusted such that the next upstream manhole shall be set at the correct elevation.

C. If the sewer is laid at a grade greater than that shown on the City, and if the Contractor can show that there are no conflicts with upstream existing utilities or obstructions, the Contractor shall adjust the grade of the next upstream manhole such that the next upstream manhole shall be set at the correct elevation. If such an adjustment, in the Engineer's opinion, is substantial, the grade adjustment shall be spread over multiple sections of the sewer. If such an adjustment, in the City's opinion, significantly reduces the sewer's capacity, the City may require the Contractor to remove and relay that portion of the sewer laid at the improper grade.

3.9 PIPE PROTECTION

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.

3.10 TESTING

All manholes shall be vacuum tested, and all gravity flow sanitary sewer joints shall be pressure tested in accordance with the requirements of Section 02650, Testing for Acceptance of Sanitary and Storm Sewers. Testing shall be performed in the presence of the Engineer.

3.11 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 the Contract Documents.

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 ++

SECTION 02735
SEWER SERVICE CONNECTIONS

PART 1 – GENERAL

1.1 SCOPE

The work covered by this Section shall consist of furnishing and installing service connections in the sewers, of the size and type shown on the Drawings and specified herein.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Service connections shall be made at the top or from the side at 45 degrees of the sewer line using diameter pipe sized as shown on the Drawings. Service pipe shall be of the same material and quality as the main sewer line.

B. If the service connection ends in rock, the Contractor shall excavate the rock an additional 10 feet beyond the plugged end.

C. Connection of service lines or risers to sewer line shall be by means of standard tees or wyes, or as indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSTALLATION

Laying of service connection lines shall be in accordance with Section 02730 of these Specifications.

+++END OF SECTION+++

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SECTION 02900

TREES, PLANTS, AND GROUND COVERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide trees, plants, and ground covers as shown and specified. The work includes:
   1. Soil preparation.
   2. Trees, plants, and ground covers.
   3. Planting mixes.
   4. Mulch and planting accessories.
   5. Existing tree care.
   6. Filling around trees to remain.
   7. Maintenance.

B. Related Work Specified Elsewhere:
   1. Section 02000 - Site Work
   2. Section 02200 - Earthwork
   3. Section 02933 – Seeding and Sodding

1.2 QUALITY ASSURANCE

A. Comply with Section 02000 requirements.

B. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

C. Comply with sizing and grading standards of the latest edition of "American Standard for Nursery Stock". A plant shall be dimensioned as it stands in its natural position.

D. All plants shall be nursery grown under climatic conditions similar to those in the locality of the project for a minimum of 2 years.

E. Stock furnished shall be at least the minimum size indicated. Larger stock is acceptable, at no additional cost, and providing that the larger plants will not be cut back to size indicated. Provide plants indicated by two measurements so that only a maximum of 25% are of the minimum size indicated and 75% are of the maximum size indicated.

F. Provide "specimen" plants with a special height, shape, or character of growth. Tag specimen trees or shrubs at the source of supply. The

Engineer will inspect specimen selections at the source of supply for suitability and adaptability to selected location. When specimen plants cannot be purchased locally, provide sufficient photographs of the proposed specimen plants for approval.

G. Plants may be inspected and approved at the place of growth, for compliance with specification requirements for quality, size, and variety.

Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.

H. Provide and pay for material testing. Testing agency shall be acceptable to the Engineer. Provide the following data:
   1. Test representative material samples proposed for use.
   2. Topsoil:
      a. pH factor.
      b. Mechanical analysis.
      c. Percentage of organic content.
      d. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.
   3. Peat Moss:
      a. Loss of weight by ignition.
      b. Moisture absorption capacity.

1.3 SUBMITTALS

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

A. Mulch samples.

B. Planting accessories samples.

C. Certification for topsoil source and pH value; peat moss and plant fertilizer.

D. Material test reports.

E. Upon plant material acceptance, submit written maintenance instructions recommending procedures for maintenance of plant materials.

F. Plant material record drawings:

G. Legibly mark drawings to record actual construction.

H. Indicate horizontal and vertical locations, referenced to permanent surface improvements.

I. Identify field changes of dimension and detail and changes made by Change Order.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer materials in original, unopened, and undamaged containers showing weight, analysis, and name of manufacturer. Store in manner to prevent wetting and deterioration.

B. Take all precautions customary in good trade practice in preparing plants for moving. Workmanship that fails to meet the highest standards will be rejected. Spray deciduous plants in foliage with an approved "Anti-Desiccant" immediately after digging to prevent dehydration. Dig, pack, transport, and handle plants with care to ensure protection against injury. Inspection certificates required by law shall accompany each shipment invoice or order to stock and on arrival, the certificate shall be filed with the Engineer. Protect all plants from drying out. If plants cannot be planted immediately upon delivery, properly protect them with soil, wet peat moss, or in a manner acceptable to the Engineer. Water heeled-in plantings daily. No plant shall be bound with rope or wire in a manner that could damage or break the branches.

C. Cover plants transported on open vehicles with a protective covering to prevent wind burn.

D. Provide dry, loose topsoil for planting bed mixes. Frozen or muddy topsoil is not acceptable.

1.5 PROJECT CONDITIONS

A. Work notification: Notify Engineer at least 7 working days prior to installation of plant material.

B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.

C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern.

D. The irrigation system may be installed prior to planting. Locate, protect, and maintain the irrigation system during planting operations. Repair irrigation system components, damaged during planting operations, at Contractor's expense.

1.6 WARRANTY

A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of 1 year after completion and acceptance of each contract item as listed in bid package.

Inspection of plants will be made by the Engineer at completion of planting.

B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Engineer, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes due to the Contractor's negligence. The cost of such replacement(s) is at Contractor's expense. Warrant all replacement plants for 1 year after installation.

C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area; acts of vandalism or negligence on the part of the Owner.

D. Remove and immediately replace all plants, as determined by the Engineer to be unsatisfactory during the initial planting installation.

PART 2 - PRODUCTS

2.1 MATERIALS

Plants: Provide plants typical of their species or variety; with normal, densely-developed branches and vigorous, fibrous root systems. Provide only sound, healthy, vigorous plants free from defects, disfiguring knots, sunscald injuries, frost cracks, abrasions of the bark, plant diseases, insect eggs, borers, and all forms of infestation. All plants shall have a fully developed form without voids and open spaces. Plants held in storage will be rejected if they show signs of growth during storage.

1. Dig balled and burlapped plants with firm, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide ball sizes complying with the latest edition of the "American Standard for Nursery Stock". Cracked or mushroomed balls are not acceptable.
2. Container-grown stock: Grown in a container for sufficient length of time for the root system to have developed to hold its soil together, firm and whole.
    a. No plants shall be loose in the container.
    b. Container stock shall not be pot bound.

3. Provide tree species that mature at heights over 25 feet with a single main trunk. Trees that have the main trunk forming a "Y" shape are not acceptable.
4. Plants planted in rows shall be matched in form.
5. Plants larger than those specified in the plant list may be used when acceptable to the Engineer.
   If the use of larger plants is acceptable, increase the spread of roots or root ball in proportion to the size of the plant.
6. The height of the trees, measured from the crown of the roots to the top of the top branch, shall not be less than the minimum size designated in the plant list.
7. No pruning wounds shall be present with a diameter of more than 1" and such wounds must show vigorous bark on all edges.
8. Evergreen trees shall be branched to the ground.
9. Shrubs and small plants shall meet the requirements for spread and height indicated in the plant list.
   a. The measurements for height shall be taken from the ground level to the height of the top of the plant and not the longest branch.
   b. Single stemmed or thin plants will not be accepted.
   c. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
   d. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.

2.2 ACCESSORIES

A. Topsoil for Planting Beds and Tree Pits: Fertile, friable, natural topsoil of loamy character, without admixture of subsoil material, obtained from a well-drained arable site, reasonably free from clay, lumps, coarse sands, stones, plants, roots, sticks, and other foreign materials, with acidity range of between pH 6.0 and 6.8.
   a. Topsoil that has been stripped and stockpiled on site shall be the topsoil to be utilized on this project. Provide additional topsoil if necessary.
   b. Provide topsoil free of substances harmful to the plants which will be grown in the soil. Provide 12-inches of topsoil in all plant beds and tree pits.
   c. Planting mixture shall be composed of four (4) parts topsoil, two (2) parts peat moss, one (1) part sharp sand and one (1) part well rotted manure, mixed together thoroughly, and worked into existing soil.

B. Peat Moss: Brown to black in color, weed and seed free granulated raw peat or baled peat, containing not more than 9% mineral on a dry basis.

Provide ASTM D2607 sphagnum peat moss with a pH below 6.0 for ericaceous plants.

C. Fertilizer:
   1. Plant Fertilizer Type "A": Commercial type approved by the Engineer, containing 5% nitrogen, 10% phosphoric acid, and 5% potash by weight. 1/4 of nitrogen in the form of nitrates, 1/4 in form of ammonia salt, and 1/2 in form of organic nitrogen.
   2. Plant Fertilizer Type "B": Approved acid-base fertilizer.

D. Anti-Desiccant: Protective film emulsion providing a protective film over plant surfaces; permeable to permit transpiration. Mixed and applied in accordance with manufacturer's instructions.

E. Premium grade shredded pine bark 3/4" to 1-1/2" diameter. Furnish in - 3 cu. ft. bags or bulk.

F. Water: Free of substances harmful to plant growth. Hoses or other methods of transportation furnished by Contractor.

G. Stakes for Staking: Hardwood, 2" x 2" x 8'-0" long.

H. Stakes for Guying: Hardwood, 2" x 2" x 36" long.

I. Guying/Staking/Wire: No. 10 or 12, gage galvanized wire.
   1. For large trees (4" caliper and greater) use turnbuckles and heavier gage wire as indicated below
      a. Stakes for Staking: Hardwood, 4"x 4"x 8'-0" long.
      b. Guying/Staking/Wire: No. 6 or 8 gage galvanized wire.
   2. Turnbuckles: Galvanized steel of size and gage required to provide tensile strength equal to that of the wire. Turnbuckle openings shall be at least 3".

J. Staking and Guying Hose: Two ply, reinforced garden hose not less than 1/2" inside diameter.

K. Tree Wrap: Standard waterproofed tree wrapping paper, 2-1/2" wide, made of 2 layers of crepe kraft paper weighing not less than 30 lbs. per ream, cemented together with asphalt. Tree wrap shall be removed at 12 months after installation of plant material.

L. Twine: Two-ply jute material.

M. Soil Separator: Rot resistant polypropylene filter fabric, water permeable, and unaffected by freezing and thawing.

N. Drainage Tile: ASTM F405 corrugated polyethylene drainage tubing, perforated.

O. Drainage Fill: AASHTO M43 #6(3/8" to 3/4") clean uniformly graded stone or gravel.

PART 3 - EXECUTION

3.1 INSPECTION

Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

3.2 CARE OF TREES TO REMAIN

A. Minor fills of 6" or less: Fill with topsoil; hand grade to required finish grade elevation.

B. Moderate fills of 12" or less: Place layer of 3/4" to 1-1/2" stone or gravel on grade. Provide aggregate depth 1/2 of fill height, minimum of 3". Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevations.

C. Deep fills over 12": Place layer of 3/4" to 1-1/2" stone or gravel on grade. Extend drainage fill to within 2" of required finish grade. Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Provide tile drainage system and vents as indicated.

D. Deep fills over 18": Place 4" depth of 1" to 2" stone or gravel fill on grade, extending three (3) feet beyond the outer branch drip line around tree branch perimeter. Cover drainage fill with polypropylene filter fabric or 1" thickness straw choke. Place 1" to 2" stone or gravel fill around tree trunk, extending to within 2" of required finish grade elevation. Fill remaining depth with loose topsoil; hand grade to required finish grade elevation. Do not place earth fill in contact with tree trunk, maintain 18" diameter of drainage fill exposed at finish grade.

3.3 PREPARATION

A. Time of planting:
   1. Evergreen material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project requirements require planting at other times, plants shall be sprayed with anti-desiccant prior to planting operations.
   2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

3. Planting times other than those indicated shall be acceptable to the Engineer.

B. Planting shall be performed only by experienced workmen familiar with planting procedures under the supervision of a qualified supervisor.

C. Locate plants as indicated or as approved in the field after staking by the Contractor. If obstructions are encountered that are not shown on the drawings, do not proceed with planting operations until alternate plant locations have been selected.

D. Excavate circular plant pits with vertical sides, except for plants specifically indicated to be planted in beds. Provide shrub pits at least 12" greater than the diameter of the root system and 24" greater for trees. Depth of pit shall accommodate the root system. Provide undisturbed tamped down topsoil to hold root ball at nursery grade as shown on the drawings. Remove excavated materials from the site.

E. Provide pre-mixed planting mixture for use around the balls and roots of the plants consisting of planting topsoil and 1/2 lb. plant fertilizer Type "A" for each cu. yd. of mixture.

F. Provide pre-mixed ground cover bed planting mixture consisting of 3 parts planting topsoil to 1 part peat moss and 1/2 lb. plant fertilizer Type "A" per cu. yd. Provide beds a minimum of 12" deep. If slopes are greater than 4 to 1 increase depth to 18".

G. Provide pre-mixed planting mixture for use around the balls and roots of ericaceous plants consisting of 2 part planting topsoil to 1 part sphagnum peat moss and 1/2 lb. plant fertilizer Type "B" per cu. yd. of mixture.

3.4 INSTALLATION

A. Set plant material in the planting pit to proper grade and alignment. Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structure. Set plant material 2"-3" above the finish grade. No filling will be permitted around trunks or stems. Backfill the pit with planting mixture. Do not use frozen or muddy mixtures for backfilling. Form a ring of soil around the edge of each planting pit to retain water.

B. After balled and burlapped plants are set, muddle planting soil mixture around bases of balls and fill all voids.

Remove all burlap, ropes, and wires from the tops of balls of trees and remove entirely from all other plant material.

C. Space ground cover plants in accordance with indicated dimensions. Adjust spacing as necessary to evenly fill planting bed with indicated quantity of plants. Plant to within 12" of the trunks of trees and shrubs within planting bed and to within 6" of edge of bed.

NOTE: Provide drainage tiles if Contractor encounters standing water in planting pits or conditions warrant.

D. Drain tile: Install drainage tile with perforations down and closed joints, firmly bedded in minimum 4" layer of granular fill material. Provide full bearing for each pipe section. Provide continuous slope in the direction of flow.

1. Provide collars and couplings for all in-line joints and elbows for all corners and changes in direction.
2. Provide unperforated run out pipe. Extend drainage tile to out fall indicated and make connection.
3. Obtain required inspections and perform testing before backfilling. Remove obstructions, replace damaged components, and retest system as required. Provide a satisfactory free flowing drainage tile system.
4. Place drainage fill over drain piping after satisfactory testing and acceptance. Compact drainage fill layers not exceeding 6" in loose depth. Exercise care to avoid damage or displacement of installed piping.
    a. Completely cover drain lines to width of at least 6" each side of pipe and above top of pipe to within 18" of finish grade.
    b. Provide soil separator over drainage fill prior to topsoil fill. Overlap a minimum of 6".
5. Install topsoil fill over compacted drainage fill. Compact topsoil fill in layers not exceeding 6" in loose depth. Extend topsoil fill to indicated finish grade elevations. Slope topsoil fill away from building.

E. Mulching:

1. Mulch tree and shrub planting pits and shrub beds with required mulching material 3" deep immediately after planting. Thoroughly water mulched areas. After watering, rake mulch to provide a uniform finished surface.
2. Mulch ground cover beds with mulch 2" deep immediately after planting.

F. Wrapping, guying, staking:

1. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
2. Wrap trunks of all trees spirally from bottom to top with specified tree wrap and secure in place.

a. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
b. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom. Wrapping and twine to be removed 12 months after installation of plant material.

3. Staking/Guying:
a. Stake/guy all trees immediately after lawn seeding or sodding operations and prior to acceptance. When high winds or other conditions which may effect tree survival or appearance occur, the Engineer may require immediate staking/guying.
b. Stake deciduous trees under 3" caliper. Stake evergreen trees under 8'-0" tall.
c. Guy deciduous trees over 3" caliper. Guy evergreen trees over 8'-0" tall.
d. All work shall be acceptable to the Engineer.

G. Pruning:
1. Prune branches of deciduous stock, after planting, to balance the loss of roots and preserve the natural character appropriate to the particular plant requirements. In general, remove 1/4 to 1/3 of the leaf bearing buds, proportion shall in all cases be acceptable to the Engineer. Remove or cut back broken, damaged, and unsymmetrical growth of new wood.
2. Multiple leader plants: Preserve the leader which will best promote the symmetry of the plant. Cut branches flush with the trunk or main branch, at a point beyond a lateral shoot or bud at a distance of not less than 1/2 the diameter of the supporting branch. Make cut on an angle.
3. Prune evergreens only to remove broken or damaged branches.

H. Care of existing trees:
1. Selectively prune existing trees in designated areas, under Engineer's direction. Remove sucker shoots, dead, rubbing, and damaged branching.
2. Fertilize designated existing trees with 2 to 3 lbs. of Type "A" plant fertilizer per inch of trunk diameter, for trees less than 6" diameter and 3 to 5 lbs. for trees greater than 6" diameter.
a. Fertilize in early spring before growth begins or in late October.
b. Fertilize at 2' to 3' on center in a triangular pattern to a depth of 18" within the dripline.
c. Injection or drilling fertilization methods, when used, shall be acceptable subject to Engineer's approval.

3. Water existing trees every 2 weeks until acceptance. Water thoroughly with a fine mist sprinkler head soaker hose or hose at a low flow rate over the entire drip line area as required to allow water to penetrate to a depth of 12" to 18".

I. Tree relocation:

Transplant trees designated for relocation to locations shown on the drawings. Prune, dig, ball and burlap, move and plant in accordance with specified tree planting requirements.

3.5 MAINTENANCE

A. Maintain plantings until completion and acceptance of the entire project.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease.
1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
2. Tighten and repair guy wires and stakes as required.
3. Remove tree wrapping and twine 12 months after installation of plant material.
4. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
5. Water trees, plants, and ground cover beds within the first 24 hours of initial planting, and not less than twice per week until final acceptance.

3.6 ACCEPTANCE

A. Inspection to determine acceptance of planted areas will be made by the Engineer, upon Contractor's request. Provide notification at least 10 working days before requested inspection date.

Planted areas will be accepted provided all requirements, including maintenance, have been complied with and plant materials are alive and in a healthy, vigorous condition.

B. Upon acceptance, the Owner will assume plant maintenance.

3.7 CLEANING

Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, soils, debris, and equipment. Repair damage resulting from planting operations.

END OF SECTION

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SECTION 02933

SEEDING AND SODDING

PART 1 - GENERAL

1.1 SCOPE

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.

B. Seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.

C. The Work shall also include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion. Temporary seeding shall be performed at the times and locations as directed by the Engineer.

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following information shall be submitted:

A. Prior to seeding operations, labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this Section.

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.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

Wood cellulose fiber mulch shall be manufactured by Weyerhauser Company or Conway Corporation.

2.2 MATERIALS AND CONSTRUCTION

A. Topsoil

1. Utilizing designated stockpiles or borrow areas on site, the Contractor shall place a minimum of 6 inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the Engineer prior to disturbance.
2. Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2 inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.
3. Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, or organic matter as determined by loss on ignition of oven dried samples to 65 Degrees C.

B. Seed

1. Seed shall be hulled common Bermuda (Cynodon Dactylon) guaranteed by the dealer to be 98% minimum purity and 90% minimum germination and certified free of giant strain Bermuda.
2. 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.
3. 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.
4. Seed shall bear the growers analysis testing to 98 percent for purity and 90 percent for germination. At the discretion of the Engineer, samples of seed may be taken for check against the grower's analysis.

5. Species, rate of seeding, fertilization and other requirements are shown in Table 02933-1 at the end of this Section.

C. Fertilizer and Liming Materials
   1. Fertilizer and liming materials shall comply with applicable state, local and federal laws concerned with their production and use.
   2. Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in Table 02933-1. Container bags shall have the name and address of the manufacturer, the brand name, net weight and chemical composition.
   3. Agricultural limestone shall be a pulverized limestone having a calcium carbonate content of not less than 85 percent by weight.
   4. Fertilizer shall be a complete fertilizer, the content of which shall meet the following minimum requirements: 10% nitrogen, 10% phosphoric acid, 10% potash, available materials. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in original unopened containers bearing the manufacturer's statement of guarantee.
   5. Ammonium Nitrate shall be a standard brand and shall be delivered to the site in original unopened containers. It shall contain not less than 33 1/3% Nitrogen.

D. Mulch Material
   1. All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.
   2. 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.
   3. Straw mulch shall be partially decomposed stalks of wheat, rye, oats or other approved grain crops.
   4. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum or other approved standing field crops.

E. Mulch Binder
   1. Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non toxic to plant life and shall be acceptable to the Engineer.
   2. Emulsified asphalt binder shall be Grade SS 1, ASTM D977. Cutback asphalt binder shall be Grade RC 70 or RC 250.

F. Inoculants for Legumes: All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen fixing bacteria that is adapted to the particular seed involved.

G. Water: Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the Contractor.

H. Sod

1. Sod shall be living, growing sod of Bermuda hybrids "Tifway 419" or Tifgreen 328". This includes sod which is dormant during the cold or dry season and capable of renewing growth after the dormant period. All sod shall be obtained from approved sources. The presence of weeds or other noxious growth or any other foreign material which may be detrimental to the proposed planting will be cause of rejection. At least 85% of the plants in the sod shall be composed of the designated variety of Bermuda grass.
2. The Engineer shall be notified of sources before it is harvested. Approval of such sources shall not be construed as an acceptance of the material. The sod will be subject to inspection while it is being planted and any material which has been permitted to dry out excessively or exposed to extreme heat, or which is not viable, will be rejected.
3. In the harvesting of the sod, grass more than 3-inches tall shall be mowed to a height of 3-inches, raked and removed before sod cutting begins. The sod shall be cut into square or rectangular sections which may vary in length, but which shall be of uniform width and thickness, and shall have at least ½-inch of soil adhering firmly to the roots. Care shall be exercised at all times to retain the soil on the roots of the sod during the process of cutting, transporting and planting. Sod shall be transplanted within 24 hours from the time it is harvested. All sod stored shall be kept moist, shall be protected from exposure to the air and sun and from freezing, and shall not be stored for more than 10 days. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected.

PART 3 - EXECUTION

3.1 SECURING AND PLACING TOPSOIL

A. Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the Engineer.

B. The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage and other characteristics as to offer assurance that, when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.

C. All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen or its residue and any other refuse which will hinder or prevent growth.

D. In securing topsoil from a designated pit, or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil or if required by the Engineer, the pit shall be abandoned.

E. Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the Engineer.

F. The areas in which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

3.2 SEEDBED PREPARATION

A. Before liming, fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line from unsightly variation, bumps, ridges and depressions and all detrimental material, roots and stones larger than 3 inches in any dimension shall be removed from the soil.

B. Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2 inches with a weighted disc, tiller, pulvimixer or other equipment, until the surface is smooth and in a condition acceptable to the Engineer.

C. If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be cultivated for seeding.

D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition, as determined by the Engineer.

3.3 FERTILIZATION AND LIMING

A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in Table 02933-1 at the end of this Section.

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 1/2 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 30 minutes when a hydraulic seeder is used.

D. Agricultural limestone shall be thoroughly mixed into the soil according to the rates in Table 02933-1. The specified rate of application of limestone may be reduced by the Engineer if pH tests indicate this to be desirable. It is the responsibility of the Contractor to obtain such tests and submit the results to the Engineer for adjustment in rates.

E. It is the responsibility of the Contractor to make one application of a maintenance fertilizer according to the recommendations listed in Table 02933-1.

F. On the approved grade, spread 20 lbs. per 1,000 sq. ft. of 10 10 10 fertilizer into top 3-inches, hand rake and smooth. The surface shall be brought to finish grade requirements, allowance being made for settlement. Finish grades shall be smooth and free from hollows or other inequalities.

G. Three weeks after construction of lawns add ammonium nitrate at the rate of 5 lbs. per 1000 sq. ft. of lawn area, and thoroughly water in.

3.4 SEEDING

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 dates shown in Table 02933-1 unless otherwise approved by the Engineer. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation.

B. Seed shall be uniformly sown by any approved mechanical method suitable for the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder or approved mechanical power drawn seed drills. Hydro seeding and hydro mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seedings at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.

C. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8 inch by a cultipacker or suitable roller.

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. Italian rye grass (Lolium Multiflorum) shall be evenly seeded with a mechanical spreader at the rate of 5 lbs. per 1000 sq. ft. of area, lightly rake, suitably compact and thoroughly water. Before planting the permanent lawn, the rye shall be thoroughly scarified in a manner to incorporate it into the top three inches of the ground.

F. The planting of bermuda grass shall be done only within the season extending from April 15 to August 1.

3.5 MULCHING

A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.

B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:

Mulch Type	**Application Rate**
Wood Cellulose Fiber	1,400 pounds/acre
Straw	4,000 pounds/acre
Stalks	4,000 pounds/acre

C. These rates may be adjusted at the discretion of the Engineer at no additional cost to the Owner, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

D. 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.

E. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates in a manner acceptable to the Engineer.

3.6 WATERING

A. The Contractor shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain adequate water content in the soil.

B. Watering shall be accomplished by hoses, tank truck or sprinklers in such a way to prevent erosion, excessive runoff and overwatered spots.

3.7 MAINTENANCE

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 areas without additional payment until final acceptance of the work by the Owner, and any regrading, refertilizing, reliming, reseeding or remulching shall be done at the Contractor's own expense. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gulleys, washouts or other causes shall be repaired by filling with topsoil, compacting and repeating the seeding work at the Contractor's expense.

C. Contractor's guarantee of one (1) year shall also cover a fully rooted stand of grass.

TABLE 02933-1

SEEDING REQUIREMENTS

Area	Sowing Season	Species	Seed	Rates per 1,000 Square Feet		
				Fertilizer	Limestone	Maintenance**
Flat to rolling terrain with slopes less than 3:1	3/1 to 4/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	10 lbs. 10-10-10
	9/1 to 11/15	Rebel II Turf-Type Tall Fescue	6-8 lbs.	30 lbs. 6-12-12	200 lbs.	15 lbs. 10-10-10
Embankments with slopes greater than 3:1	3/1 to 6/1	Crownvetch* Kentucky 31 Fescue Weeping Lovegrass	1 lb. 2 lbs. 1/4 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20
	8/1 to 11/1	Crownvetch* Kentucky 31 Fescue Annual Ryegrass	1 lb. 2 lb. 2 lb.	30 lbs. 6-12-12	200 lbs.	10 lbs. 0-20-20

* Requires inoculation
** Maintenance fertilizer shall be applied in early spring following initial establishment of cover

END OF SECTION

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DIVISION 3

CONCRETE

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SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install the concrete formwork as required by the concrete outlines shown and indicated on the Drawings and specified in this Section, complete. The use of stay in place forms is expressly prohibited.

B. Coordination:

Notify other contractors in advance of the trades of the formwork to provide the other trades with sufficient time for the installation of items included in their contracts that must be installed with the formwork.

C. Form Design:

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 347.

D. Related Work Specified Elsewhere:
Section 03250, Concrete Joints

1.2 SUBMITTALS

A. 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.

B. Do not provide submittals for the structural design of forms.

1.3 QUALITY ASSURANCE

A. Allowable Tolerances:
1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347.
2. Maximum acceptable deflection is 1/8" in 5'-0" on all flat surfaces (ACI 347 Class A Finish).

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.

1.4 PRODUCT DELIVERY. STORAGE AND HANDLING

A. On delivery to jobsite, place materials in area protected from weather.

B. Store materials above ground on framework or blocking. Cover wood for forms with protective waterproof covering. Provide for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. 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.

B. Forms for Unexposed Finish Concrete: (Rough Finish)

Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1 side.

C. Form Ties:

1. Provide factory-fabricated, removable or snap off metal form ties designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying Forms will be subject to approval of 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 integral with the tie, preferably a solid washer at mid-point of the tie.
4. Provide wood or plastic cones for ties, where concrete is exposed in the finished structure.

D. Forms Coatings:

Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 - EXECUTION

3.1 DESIGN OF FORMWORK

A. Formwork shall be in accordance with ACI 347 and as follows:

1. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.
2. Design forms and false work to include make full allowance for all of live loads, dead loads, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
3. Forms shall conform to shape, lines and dimensions of members indicated and shall be sufficiently rigid and tight to prevent leakage of mortar. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms shall be carefully made and accurately placed to obtain correct shape and lines.
4. Joints shall be butted tight. Arrangements of panels shall be orderly and symmetrical, and use of small pieces shall be avoided. Forms shall be chamfered 1-inch for external corners of concrete, including tops of walls, which will be exposed to view in the finished work.
5. Provide adequate formwork in its entirety. Forms shall safely support loads they will sustain and shall maintain their dimensional and surface correctness to produce members required by the Drawings. Form ties shall be spaced close enough to avoid bulges and variations in the required cross-sectional dimensions shown on the Drawings for the members being cast.
6. Box out for chases, recesses or other openings required in the completed 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. Provide a sufficient number of cleanout doors at the base of walls and columns to facilitate cleaning and the application of grout to the base of walls.
10. 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, recessed 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 ¾ by ¾ 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:

See Specification Section 03250 and Drawings for treatment of joints. Locate as shown and specified.

E. Cleaning and Tightening:

Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Re-tighten forms immediately after concrete placement as required to- eliminate mortar leaks.

3.2 FORM COATINGS

A. Coat form contact surfaces with a non-staining no petroleum formcoating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces, which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon or that as acceptable in the State, County, or District of their intended use, whichever is more stringent.

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.

3.3 INSTALLATION OF EMBEDDED ITEMS

A. General:
1. Set and build into the formwork, anchorage devices and other embedded items, shown specified or required by other Section. Refer to paragraph 1.01 herein for the requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.
2. All embeds should be supported, plumbed and carefully taped or covered to prohibit the infiltration of concrete during the pour.
3. Coat any aluminum or reactive metal inserts, with non-reactive coating to isolate the metal surfaces.

B. 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.

3.4 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. He 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.

3.5 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 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

3.6 REUSE OF FORMS

Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable.

Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

A. 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.

B. Metal surfaced forms must have a smooth even surface without plate patches.

END OF SECTION

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SECTION 03200

CONCRETE REINFORCEMENT AND DOWELLING

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to provide concrete reinforcement and dowelling as shown and specified.

B. The extent of concrete reinforcement and dowelling is shown on the Drawings.

C. The Work includes fabrication and placement of reinforcement including bars, ties and supports for concrete and encasements.

D. Related Work Specified Elsewhere:
1. Section 03100, Concrete Formwork
2. Section 03250, Concrete Joints
3. Section 03300, Cast-In-Place Concrete.
4. Section 03600, Grout.

1.2 SUBMITTALS

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

A. Shop Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315, Chapters 1 thru 8. Show bar schedules, stirrup spacing, diagrams of bent bars, arrangements and assemblies, as required for the fabrications and placement of concrete reinforcement unless otherwise noted. Splices shall be kept to a minimum. Show construction joints.

B. Copies of manufacturer's specifications and installation instructions for all materials and reinforcement accessories.

C. 5 copies of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1.3 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. 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. Concrete Reinforcing Steel Institute, "Manual of Standard Practice", includes ASTM standards referred to herein.
2. ACI 318, "Building Code Requirements for Reinforced Concrete".
3. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
4. ACI 350, Environmental Engineering concrete structures.
5. Concrete Reinforcing Steel Institute, Placing Reinforcing Bars.
6. AWS D.1, Structural Welding Code.

C. Minimum Concrete Cover for Reinforcement: Comply with ACI 350, except as shown on Drawings:

D. splices other than lap splices shall not be used except where permitted in writing by the Engineer.

E. Reinforcement which arrives on the jobsite which is not tagged as specified in Paragraph 1.04A shall be rejected by the Engineer and removed at the Contractor's expense.

1.4 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 damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars and Dowelling: ASTM A 615, Grade 60, where welding is not required, or ASTM A706, Grade 60, for reinforcing to be welded.

B. Steel Wire: ASTM A82.

C. Welded Smooth Wire Fabric: ASTM A185:

Furnish in flat sheets, not rolls.

D. Supports for Reinforcement: Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB. Precast concrete block supports shall be provided for reinforcing in concrete cast against grade.

E. Mechanical Connections:
   1. Metal Sleeve. Steel sleeve with cast filler metal, capable of developing, under tension or compression, 125 percent of specified yield strength of the reinforcing bar. Metal sleeve shall be as manufactured by:
      a. Erico Products, Inc., Cleveland, OH.
      b. Or equal.
   2. Mechanical Threaded Connection. 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 bar. Mechanical threaded connection shall be as manufactured by:
      a. Erico Products, Inc., Cleveland, OH, Lenton Reinforcing Steel Couplers.
      b. Richmond Screw Anchor Co., Inc., Fort Worth, TX, Richmond DB-SAE Dowel Bar Splicers.
      c. Or equal.

F. High Strength Bars. High strength bars shall be 150 KSI steel conforming to ASTM A-722, threaded full length. Anchor nuts shall be manufacturer's standard designed for use with bars. Mechanical couplers, when required, shall be capable of developing 100% of guaranteed ultimate strength of the bars.

2.2 FABRICATION

A. General: Fabricate reinforcing bars and dowelling to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice" and ACI minimums. In case of fabricating errors, do not re-bend, retemper, heat, deform or straighten reinforcement.

B. Unacceptable Materials: Reinforcement with any of the defects listed below will not be permitted in the Work:
   1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
   2. Bends or kinks not shown on approved Shop Drawings.
   3. Bars with reduced cross-section due to excessive rusting or other cause.
   4. Surface contamination that would affect the bond i.e. grease, dirt, paint, rust etc.
   5. Heat deformed or torched bars.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI "Placing Reinforcing Bars" and ACI requirements for details and methods of reinforcement placement and supports.

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

C. Position, support, and secure reinforcement and dowelling against displacement during formwork construction or concrete placement and grouting operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required. No wood blocks allowed for rebar support.

1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 350. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.
2. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16 gauge wire and tie.

E. Provide sufficient numbers of supports of strength required to carry reinforcement without sagging. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

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

G. Dowels to be embedded a minimum of 8 inches into existing concrete unless otherwise specified on the drawings. Grout with an approved epoxy grout, per Section 03605 of these Specifications.

H. Existing concrete which is shown to remain but is removed in error or must be removed to install new Work, is to be reinforced to the extent as required and approved by the Engineer. This work will be performed with no additional compensation to the Contractor.

I. Do not straighten or rebend reinforcing.

J. Reinforcement Around Openings: Place an equivalent area of steel around the pipe or openings and extend on each side sufficiently to develop bond in each bar. See the Details on the Drawings for bar extension length each side of openings. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.

K. Welded Reinforcement: Welding shall not be permitted unless the Contractor submits detailed shop drawings, qualifications, and radiographic nondestructive testing procedures for review by the Engineer. Reinforcing bars to be welded shall conform to ASTM A706; other bars shall not be welded. The Contractor shall obtain the Engineer's approval prior to proceeding. The basis for the Contractor submittals shall be The Structural Welding Code, Reinforcing Steel, AWS D1.4-79, published by the American Welding Society and the applicable portions of ACI 318, current edition. The Contractor shall test 10 percent of all welds using radiographic, nondestructive testing procedures referenced in this code.

3.2 INSPECTION OF REINFORCEMENT

A. After the rebar, appliance, anchors and embedments have been installed and checked, the Contractor shall review all aspects of the pending concrete pour and initial those items on its pour card. Contractor shall notify the Engineer no less than 24 hours prior to the pour, so that the Engineer may check the area and pour. No concrete shall be placed until this is complete.

B. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by the Engineer. All concrete placed in violation of this provision will be rejected. Rejected concrete shall be removed and replaced at no cost to the City.

END OF SECTION

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SECTION 03250

CONCRETE JOINTS

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to provide concrete joints as shown and specified.

B. The types of concrete joints required include the following:
1. Construction joints.
2. Expansion joints and fillers.
3. Waterstops.

C. General: All joints subject to hydrostatic pressure shall be provided with continuous waterstop.

D. Related Work Specified Elsewhere:
1. Section 03100, Concrete Formwork.
2. Section 03200, Concrete Reinforcement and Dowelling
3. Section 03300, Cast-In-Place Concrete.
4. Section 03600, Grout.
5. Section 07900, Caulking and Sealants.
6. Section 09900, Painting.

1.2 SUBMITTALS

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

A. Product data for all materials stating the location where product is to be used.

B. Certification that materials meet the specifications.

C. Manufacturer's application and installation instructions.

D. Samples of water stops, concrete roughener, joint fillers, caulk and bonding agent if requested by the Engineer.

1.3 QUALITY ASSURANCE

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

1. ACI 301, Specifications for Structural Concrete for Buildings, Chapter 6, Joints and Embedded Items.
2. ACI 350, Environmental Engineering concrete structures, Chapter 2.8, Joints.
3. ASTM D 1752, Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction.

B. All manufactured items shall be installed in accordance with manufacturer's instructions.

C. Construction and expansion joints shall not be added or relocated without the approval of the Engineer.

PART 2 - PRODUCTS

2.1 JOINT SEALER

A. Materials shall be two component, polyurethane meeting ASTM-C-920 and FED SPEC TT-S-00227E specifications. Materials shall have + 50% movement.

B. Manufacturer and Product shall be:
1. Horizontal Joint - Sikaflex 2C Self Leveling by Sika Corp or equal.
2. Vertical Joint - Sikaflex 2C Non-Sag by Sika Corp or equal.

2.2 CONSTRUCTION JOINTS

Bonding Agent - Shall meet ASTM C 881 with a bond strength of 1500 psi minimum. Agent shall be capable of spraying in inaccessible locations, if necessary.

Manufacturer and Product shall be:

A. Sika Armatic 110 by Sika Corp.

B. Sikadur 32 Hi-Mod by Sika Corp.

C. Or equal.

2.3 JOINT FILLER

Expansion Joint Material: Type I, preformed sponge neoprene expansion joint filler conforming to AASHTO Designation M-153.

2.4 WATERSTOPS

Waterstop shall be PVC (Polyvinylchloride) meeting ASTM D-638 test method for tensile strength of 2020 psi and ultimate elongation of 370.

A. Construction joints:
   1. Serrated with center bulb, 3/8" thick by 6" minimum width, Greanstreak #706 or equal.
   2. Preformed plastic adhesive waterstop, Synko-Flex Products or equal. Use only where shown on Drawings.

B. Expansion Joints: Serrated with center bulb, 3/8" thick by 9" minimum width, Greanstreak #738 or equal.

PART 3 - EXECUTION

3.1 CONSTRUCTION JOINTS

A. General:
   1. Comply with ACI 301, Chapter 6, and ACI 350, Chapter 2.8.3 and as specified below.
   2. Provide waterstops in construction joints as shown and as specified in this Section.
   3. All joints between new and existing concrete to comply with Article 3.01 of this Section.

B. Installation:
   1. Brush blast new and existing concrete surfaces at joint and surrounding area. Dry, oil-free air to be used for blasting operation. Blasting to be sufficient to remove laitance and solid contaminants, open up surface voids, bugholes, air pockets and other subsurface irregularities but not expose underlying aggregate. The abrasive shall be dry and clean and will pass through a 16 mesh screen. After blast cleaning is completed, residual abrasive dust and loose particles are to be removed from the surface by vacuuming or by compressed air. Blasting operation is to be repeated if requested by the Engineer at no additional compensation to the Contractor.
   2. Install waterstop and bonding agent per manufacturer recommendations and this Section. Spray on epoxy bonding agent in inaccessible areas per manufacturer's recommendations.
   3. Place a 6-inch grout charge of similar proportions to the cement in the concrete, over the damp, clean horizontal contact surface of the old concrete. Place fresh-concrete before the grout has attained its initial set. Grout shall be ordinary cement-sand grout as specified in Section 03600.
   4. When concrete has been placed and the form removed, wash loosened material off with high pressure water spray to obtain roughened surface subject to approval by Engineer, prior to rub finish.

5. Cure concrete sufficiently prior to placement of joint filler and epoxy coating to obtain optimum bond as per manufacturer's recommendations.
6. Apply approved epoxy joint filler per Section 07900.
7. Apply approved epoxy coating per. Section 09900.
8. Install appliances per drawings and specifications.

3.2 WATERSTOPS

A. General:
1. Comply with ACI 301, Chapter 6, Section 3.01 B and as specified below. All joints shall be made in accordance with manufacturer's instructions.
2. Obtain Engineer's approval for waterstop locations not shown.

B. Polyvinyl Chloride Waterstop:
1. Tie waterstop to reinforcement so that it is securely and rigidly supported in the proper position during concrete placement to insure their proper positioning. Puncturing waterstop with tire wire to secure it to reinforcement is prohibited.
2. Waterstops shall be fused using equipment as supplied by or recommended by the manufacturer. Heat welded at all splice points.
3. Provide sufficient bed of epoxy grout, after sandblasting, cleaning roughening and priming the surface, so as to fill all voids including the "V" at the split.
4. Install split-bulb PVC waterstop onto the non-shrink, non-metallic grout bed. Mount waterstop to wall using two (2) 1/4" x 2" type 316 stainless steel strips on either side of the waterstop anchored with 1/2" diameter type 316 stainless steel anchor bolts on 12" centers.
5. Fill all voids between the waterstop and the concrete with approved epoxy grout with no additional compensation to the Contractor if injection method is used.
6. Obtain final Engineer's approval of the waterstop installation prior to placing concrete.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install the cast-in-place concrete as shown and indicated on the Drawings and as specified in this Section, complete.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.
2. Notify other trades in advance of the placing of concrete to provide the other trades with sufficient time for furnishing of items included in their work that must be installed in the concrete.
3. Required City formal pour card with all required signatures.

C. The following classes of concrete may be required. As listed below or refer to the drawings for their locations.
1. Class B, Precast concrete units
2. Class D, all location unless otherwise noted.
3. Class G, pipe encasements, duct banks, fill and curbs.

D. Related Work Specified Elsewhere:
Section 03250, Concrete Joints

1.2 SUBMITTALS

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

A. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.

B. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. Production of concrete to comply with specified requirements is the responsibility of the Contractor. Submit the testing lab's average strength curve from the design mix proportions of the approved materials.

D. Notarized certification of conformance to referenced standards to the Engineer and a copy of the batch plant's most recent scale calibration.

E. Delivery Tickets: Furnish to Engineer copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 14.

1.3 QUALITY ASSURANCE

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

1. ACI 301, Specification for Structural Concrete for Buildings, (includes ASTM Standards referred to herein).
2. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
3. ACI 305, Recommended Practice for Hot Weather Concreting.
4. ACI 306, Recommended Practice for Cold Weather Concreting.
5. ACI 308, Standard Practice for Curing Concrete.
6. ACI 309, Recommended Practice for Consolidation of Concrete.
7. ACI 318, Building Code Requirements for Reinforced Concrete.
8. ACI 347, Recommended Practice for Concrete Formwork.
9. ASTM C31, Standard Method of Making and Curing Concrete Test Specimens in the Filed.
10. ASTM C33, Standard Specification for Concrete Aggregates.
11. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
12. ASTM C40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
13. ASTM C42, Standard Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
14. ASTM C94, Standard Specification for Ready-Mixed Concrete.
15. ASTM C138, Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
16. ASTM C143, Standard Test Method for Slump of Portland Cement Concrete.
17. ASTM C150, Standard for Portland Cement.
18. ASTM C157, Standard Test Method for Length Change of Hardened Cement Mortar and Concrete
19. ASTM C171, (1986) Standard Specification for Sheet Materials for Curing Compounds.
20. ASTM C172, Standard Method of Sampling Freshly Mixed Concrete.
21. ASTM C173, Standard Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
22. ASTM C192, Standard Method of Making and Curing Concrete Test Specimens in the Laboratory.

23. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
24. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.
25. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.
26. ASTM C827, Standard Test Method for Early Volume Change of Cementitious Mixtures.
27. Federal Specification CCC-C-467C: Cloth, Burlap Jute or Kenaf.

B. Concrete Testing Service:
1. Contractor shall employ, at its own expense, a testing laboratory, approved by the Engineer and experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
    a. Testing agency shall meet the requirements of ASTM E 329.
    b. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information, which may be requested by the Engineer.
    c. Submit certification that the testing laboratory meets the requirements of ASTM E329.
2. Materials and installed Work may require testing and retesting, as directed by the Engineer, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times.
3. Contractor will employ independent testing laboratory to perform testing for concrete field quality control as specified under paragraph 3.13 of this Specification.

C. Test for Concrete Materials:
Submit written reports to the Engineer, for each material selected and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each materials, and test results. Indicate acceptability of materials for intended use.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to insure

that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement:
   1. Portland cement, ASTM C 150, Type II.
   2. Do not use cement which has deteriorated because of improper storage, handling or for any other reason.

B. Aggregates: ASTM C 33 and as herein specified.
   1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces. Slag materials are not allowed.
   2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
      Dune sand, bank run sand and manufactured sand are not acceptable.
   3. Coarse Aggregate: Clean granitic, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.

C. Water: Clean, free from injurious amounts of oils, acids, alkalis, potable, organic materials or other substances that may be deleterious to concrete or steel.

2.2 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instruction. Do not use admixtures, which have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by the Engineer.

B. Water-Reducing Admixture: ASTM C 494, Type A.

C. Air entraining admixture shall conform to ASTM C 260.

D. Fly ash shall conform to ASTM C 618, Type F.

E. High range water reducer (HRWR) shall conform to ASTM C 494, Type G.

F. Calcium Chloride: Do not use calcium chloride in concrete.

G. Silica fume shall conform to ASTM C 1240.

2.3 PROPORTIONING AND DESIGN OF MIXES

The following classes of concrete are required.

Class of Concrete	Compressive Strength @ 28 Days	Slump Range Before HRWR	Slump Range After HRWR	Maximum W/C Ratio	Coarse Aggregate Size
B	5,000	1" – 2"	6" – 9"	0.40	57
D	4,500	1" – 2"	6" – 9"	0.42	67
G	3,000	1" – 4"	N/A	0.55	57

*High Range Water Reducer (HRWR)

A. Fly ash is required in Class D concretes. The fly ash shall not exceed more than 20% of combined weight of fly ash and cement. The fly ash shall not be less than 15% of the combined weight of fly ash and cement. The combined weight of cement and fly ash shall be used as the weight of cement in the determining of the water-cement (w/c) ratio.

B. Slump tests shall be made prior to adding the HRWR. The HRWR shall be added to the concrete at the batch plant. The slump range required after the addition of the HRWR is indicated in the table above. HRWR shall be capable of maintaining the required slump in excess of 60 minutes of continuous mixing at 4 to 6 rpm in a truck mixer and workability up to 90 minutes. Upon 72 hours notice, the HRWR manufacturer shall supply jobsite technical service to the Contractor. The manufacturer shall be consulted for mix proportions and dosage rates. The initial set shall not be in excess of six hours at temperatures above 50 degrees F. HRWR shall be used with due consideration given to the air temperature at the time of batching and casting.

C. If field experience method is used to select concrete mixes, the proposed mix designs shall be accompanied by complete standard deviation analysis and at least 20 consecutive strength test that represent the proposed mix.

D. The proposed mix design and supporting data shall be submitted, in triplicate, to the Engineer at least 30 days prior to the expected start of concreting operations.

E. Compression test specimens made to verify the mixes shall be made in accordance with ASTM C 192. All compression test specimens shall be tested in accordance with ASTM C 39.

F. Adjustment to Concrete Mixes During Construction: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the owner and as accepted by Engineer. Laboratory test data for revised mix designs and strength results must be submitted to the Engineer for acceptance before using the revised mixes.

G. Mix design shall be proportioned in accordance with ACI 211.1 making maximum use of the coarse aggregate. The proportioning shall be based on the requirements of a well-graded high density plastic workable mix within the slump range and strengths required. The mix shall be based on conventional conveying and shall not be altered for use in pumping. Pumping equipment, if used, shall be of sufficient size and design to pump the mix designed for conventional conveyance.

H. Submit samples, in adequate quantities for each mix design and verification, of all concrete materials to be used on the project to the contractors testing laboratory. Do not use any concrete in this work without acceptance and verification of design mix by the contractors testing laboratory and the approval of the Engineer.

I. If Laboratory trial batches are used to select concrete mixes, the contractors testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the Contractor. The contractors testing laboratory shall prepare trial batches in accordance with ACI 211.1.

J. Class D concrete shall have an air content of 6% ± 1½%.

2.4 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute of kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. 4 mil polyethylene.

C. Curing and Sealing Compound: ASTM C-309.

PART 3 - EXECUTION

3.1 CONCRETE MIXING

General:

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 of 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. Replace mixer blades when they have lost 10 percent of their original height.
4. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".
5. Mix concrete in revolving type truck mixers, which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
6. Do not exceed the proper capacity of the mixer.
7. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
8. Do not allow the drum to sit while in transit.
9. Mix at proper speed until concrete is discharged.
10. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.
11. The Contractor shall ensure that the silica fume is uniformly dispersed throughout the concrete in accordance with mixing procedures recommended by the silica fume supplier.

3.2 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete, and do not add any water at the jobsite.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.3 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.

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.

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, per Section 03250, 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 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 50^0 F and 70^0 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 insure that the ambient temperature does not fall below 300 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 55^0 F and not more than 90^0 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 and as herein specified.
2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90^0 F when the temperature is rising and below 85^0 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.

3.4 CONSTRUCTION JOINTS

A. Formed Construction Joints in Containment Structures and Where Otherwise Shown: Prior to placing concrete next to the joint, the joint surface shall be thoroughly cleaned and dampened with water. Remove all free water so that the surface of the joint shows signs of drying before placing the adjacent concrete.

B. Construction Joints in Beams, Girders and Slabs: These joints shall be located at points of minimum shear and their locations shall be approved by the Engineer before they are bulkheaded. These joints shall be roughened and thoroughly cleaned of all foreign matter and laitance and dampened with water. Remove all free water and slush with a coat of neat cements grout before placing the adjacent concrete. Place the adjacent concrete before the neat cements grout takes its initial set.

3.5 WATERSTOPS

Waterstops shall be provide where specified and as indicated and noted on the Drawings and shall be made continuous throughout their length.

3.6 FINISH ON FORMED SURFACES

A. Smooth Form Finish is required for all concrete surfaces exposed to view in the completed work and inside surfaces of all liquid containment structure walls 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.
4. Remove form ties and fill in indentations.

B. 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.

3.7 STEEL TROWELED FINISH – FLOOR SLABS

A. Steel troweled finish shall be applied to the surface of all building and liquid containment structure floor slabs and interior equipment pads.

B. Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the surface shall be wood floated, by hand or power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed ¼-inch under a 10 foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the Drawings.

C. After the concrete has received a wood float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture

between floating or troweled shall not be hastened by the dusting on of dry sand or cement. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be in true plane within the tolerance specified. Any deviation from this condition, which remains after the troweling is completed shall be corrected by grinding.

3.8 WOOD FLOAT FINISH

A wood float finish shall be applied as shown on Drawings.

3.9 BROOM FINISH

A. Broom finish shall be applied to:
   1. All exterior side walks, walkways and platforms.
   2. All steps and landings, both interior or exterior.

B. The surface shall be given a floated finish as specified above, then finished with a flexible bristle broom or burlap belt drawn across the surface. Surface must be hardened sufficiently to retain the scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

3.10 PROTECTION

Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of slabs will be permitted for the first 14 days after placing of the concrete.

3.11 CURING

A. Curing shall conform to ACI 308 except as modified herein.

B. All Slabs on Grade: After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days. Concrete shall be kept moist by any one, or combination, of the following methods:
   1. Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.

2. Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
3. Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.
4. Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting lot less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Inspect surface of concrete daily for wetness. The surface shall be kept continuously wet during the curing period.

C. All Other Concrete:

After placement, concrete shall be maintained in a moist condition for the same periods as specified above for slabs on grade. For concrete in formed surfaces, keep forms wet with water during the curing period. If forms are removed before the end of the curing period, continue the moist curing in accordance with Paragraph B of this article of these Specifications.

3.12 PATCHING

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 path 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. Defective areas shall be chipped away to a depth of not less than 1-inch, in all cases to sound concrete, with edges perpendicular to the surface. Feather edges will not be permitted. Remove all loose material and thoroughly clean the chipped surfaces with a high pressure air hose delivering air at 100 psi. The area to be patched and an area at least 6-inches wide surrounding it shall be dampened. A bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surfaces as noted in paragraph 5.
4. The patching mixture shall be made of the same materials and of approximately the same portions as used for the original concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp, loose volume. While Portland cement shall be substituted for a part of the gray Portland cement to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.
5. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Finishing tools that produce a finish matching the surrounding shall be used.

E. Tie holes left by withdrawal of rods or the holes lefty by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth. Mortar shall consist of one part cement, two and one-half parts sand and no more water than necessary for handling and packing.

3.13 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. Compression test specimens shall be tested in accordance with ASTM C 39. Test reports shall show all pertinent data, such as class of concrete, exact location of pour, air temperature, date of pour, time of pour, truck number for ready-mixed concrete, date on which specimen was broken, age of specimen, compressive strength of specimen, concrete slump test results and air content of concrete from which the specimen was made. One copy each of all tests shall be sent to the Contractor and two copies each to the Engineer.
2. Each strength test requires four standard test cylinders.
3. 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.
4. Each class of concrete shall be tested with at least five strength tests.
5. Each set of four cylinders, two shall be tested at 28 days and shall comprise a strength test under the definition of these Specifications. One cylinder shall be broken at seven days and will be used as an aid in determining the early strength of the concrete and the 28 day strength, and one cylinder retained in reserve for later testing if required.
6. 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.

B. Periodically inspect the batching plant and file a report with the Engineer stating whether the supplier's equipment and methods meet the requirements of these Specifications.

C. Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

D. All work and reports shall comply with Applicable Industry Standards.

3.14 EVALUATION OF COMPRESSION TESTS

A. Evaluation of compression test results shall be as follows: 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. 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. Specimens shall be molded by the field testing laboratory at the same time and from the same samples as the laboratory-cured specimens.

B. Faulty Concrete: Failure to comply with any of the specified conditions shall constitute faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Owner.

C. Additional Test: If permitted by the Engineer, additional tests shall be subject to the approval of the Engineer at no expense to the Owner. Load tests, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Engineer.

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.

3.15 TESTING FOR WATERTIGHTNESS OF CONCRETE STRUCTURES

A. Leakage testing shall be carried out in accordance with ACI 350.1 - Tightness Testing of Environmental Engineering Concrete Structures. The test criterion shall be HST-NML (no measurable loss) as defined by ACI.

B. All concrete structures designed to contain or convey fluid shall be tested for water tightness by the Contractor prior to earth backfilling by filling with water to levels approximately what will be attained during operation and measuring the drop in level due to leakage, if any. These tests shall be made under the direction of the Engineer, and if necessary the tests shall be repeated until water tightness is insured. Perform tests prior to backfilling below grade structures and prior to installations of any coating.

C. Rate of filling shall be limited to minimize shock-effect to new concrete construction. Water shall be held under each condition long enough to satisfy the Engineer that the structures are watertight. Structures shall be free of internal or external water leakage.

D. Leakage shall be located and stopped and the structure again tested until this requirement is met. If the structure does not meet the test, the Contractor shall repair or replace at his own expense, such part of the work

as may be necessary to secure the desired results, as approved by the Engineer.

E. Regardless of the rate of leakage there shall be no visible leakage from any concrete structure.

END OF SECTION

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SECTION 03450

PRECAST CONCRETE UNITS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes manufacture and furnishing all labor, materials, equipment, tools and incidentals required for a complete manufacture and installation of precast concrete units. All materials shall be placed in accordance with these Specifications and as shown on the Drawings.

B. Related Work Specified Elsewhere:
1. Division 3, Concrete.
2. Section 07900, Caulking and Sealants.

1.2 SUBMITTALS

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

1. Sample panels of adequate size (12 inch x 12 inch minimum) to show the full range of color and texture. Submit a separate panel for exposed face finish and one for the back face.
2. Drawings showing complete design and installation information, including reinforcing steel and accessories. Show all units in full elevation with specific markings to be used on finished units. Show locations and details of all openings, connections, bearing points and shims.

1.3 QUALITY ASSURANCE

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

A. ASTM C-35, Concrete Cylinder Test.
B. ASTM C-97, Water Absorption.
C. ASTM C-143, Slump Test.
D. ASTM C-150, Requirements for Portland Cement.
E. ASTM A-36, Structural Steel.
F. ASTM A-165, Anchors.
G. ASTM A-184, fabricated Steel Bars and Rod Mats.
H. ASTM A-185, Welded Wire Fabric.

I. ASTM A-306, Carbon Steel Bars.
J. ASTM A-307, Anchor Bolts.
K. ASTM A-497, Welded Deformed Steel.
L. ASTM A-615, Deformed Steel Bars.
M. ACI 318-89.

1.4 QUALITY STANDARDS

A. Precast concrete products manufacturer is required to have a minimum of 5 years experience in precast concrete work. Submit evidence that the manufacturer selected has the personnel, facilities, design expertise and quality control program necessary to furnish the required units.

B. Manufacturer shall provide written certification that the products provided under this Specification has been designed in accordance with these specifications and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

C. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the precast concrete units manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:
1. Metromont Materials Corp.
2. Tindall Concrete Georgia, Inc.
3. Or equal.

1.5 CONCRETE TESTING

A. Make and test concrete cylinders (6-inch x 12-inch) in accordance with ASTM C39.

B. Make a set of four cylinders with each sample panel. Submit test reports with sample panels.

C. Make a minimum of four cylinders for each 15 cubic yards of concrete during production. Test two cylinders at seven days and two at 28 days.

D. Cure cylinders in a manner identical to the finished units. The manufacturer's laboratory shall be open to the inspection of the Engineer at all times during production of the precast units.

1.6 WARRANTY

Provide a written warranty to the City that precast work will remain free from structural defects, leakage and other defects for a period of 3 years from final acceptance.

PART 2 MATERIALS

2.1 CONCRETE

A. Concrete shall have a minimum compressive strength of 5,000 psi at 28 days. Slump shall not exceed ½-inch when tested in accordance with ASTM C143. Water absorption at 28 days shall not exceed 6% when tested in accordance with ASTM C97.

B. Portland Cement shall conform to ASTM C150 Type II gray color. The same branch, type and source of supply shall be used throughout.

C. Aggregates shall be fine and coarse materials consisting of clean, hard, strong and durable inert materials free of deleterious substances.

D. Water shall be potable water free of any matter that may interfere with the color, setting, strength or performance of the concrete.

2.2 REINFORCING STEEL

A. Deformed steel bars shall meet the requirements of ASTM A615, Grade 60.

B. Wire fabric shall meet the requirements of ASTM A185 for welded steel and ASTM A497 for welded deformed steel.

C. Fabricated Steel Bars or Rod Mats shall meet the requirements of ASTM A184.

2.3 CAST-IN ANCHORS

A. Carbon steel bars shall meet the requirements of ASTM A306, Grade 65.

B. Structural steel sections shall meet the requirements of ASTM A36. Anchor bolts shall meet the requirements of ASTM A307.

C. Anchors shall be cadmium coated according to ASTM A165.

D. Provide inserts for masonry ties to anchor veneer to precast panels. See Division 4 for spacing.

2.4 MANUFACTURE OF PRECAST CONCRETE PANELS

A. Manufacturing procedures shall be in general compliance with PCI MNL-116.

B. Manufacturing tolerances shall comply with PCI MNL-116.

C. Finishes:
   1. Standard underside: Resulting from casting against approved forms using good industry practice in cleaning of forms, design of concrete mix, placing and curing. Small surface holes caused by air bubbles, normal color variations, normal form joint marks, and minor chips and spalls will be tolerated, but no major or unsightly imperfections or honeycomb, or other defects will be permitted.
   2. Standard top: Result of vibrating screed and smooth trowel finish. Normal color variations, minor indentations, minor chips and spalls will be tolerated. No major or unsightly imperfections or honeycomb, or other defects will be permitted.
   3. Exposed vertical ends: Ends of the members shall receive sacked finish.

D. Patching: Shall be acceptable provided the structural adequacy of the product and the appearance are not impaired.

E. Fasteners: manufacturer shall cast in masonry anchors, structural inserts, bolts and plates as detailed or required by the Drawings.

PART 3 - ERECTION

3.1 PRE-ERECTION INSPECTION

A. Upon delivery and before erection of precast units to the job site, the Contractor shall inspect the units for compliance with Contract requirements. Units shall be true to dimensions with an allowable tolerance of ±¼ inch in 10 feet in width and height; 1/8-inch ±¼ inch in thickness, with the face held in perfect plane. Units shall be free of all form marks and shall all accessories necessary for handling and erection.

B. All units that are warped, cracked, chipped, stained or which in an way fail to comply with contract requirements shall be subjected to rejection.

C. Defective units which in the Engineer's judgment are "job site repairable" may at the Contractor's option be repaired on the job site. Repairs shall be subject to the Engineer's approval and rejection of repaired units shall not justify extra cost or extension in Contract Time.

3.2 ERECTION OF PANELS

A. Set units plumb and square, shimming or adjusting as necessary. Provide temporary bracing to maintain position, stability and alignment as units are permanently connected.

B. Closing of all joints shall be performed as shown on the Drawings and/or specified under Section 07900 - Caulking and Sealants.

3.3 CLEANING

After installation, all units shall be cleaned by methods which will not damage precast units, sealants or adjacent materials.

+++END OF SECTION+++

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SECTION 03600

GROUT

PART 1 - GENERAL

1.1 SCOPE

A. The work covered under this Section includes furnishing all labor, materials, equipment, and incidentals required to provide grout as shown and specified.

B. The types of grout include the following:
1. Non-shrink, epoxy type.
2. Non-shrink, non-metallic type.
3. Ordinary cement-sand.
4. Refer to Section 03300 for pressure grouting applications.

C. Related Work Specified Elsewhere:
1. Section 03100, Concrete Formwork.
2. Section 03200, Concrete Reinforcement and Dowelling.
3. Section 03250, Concrete Joints.
4. Section 03300, Cast-In-Place Concrete.
5. Section 09900, Painting.

1.2 SUBMITTALS

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

A. Copies of manufacturer's specifications and installation instructions for all proprietary materials.

B. Reports and Certificates:
1. For proprietary materials, submit copies of reports on quality control tests.
2. For nonproprietary materials, submit certification that materials meet specification requirements.

1.3 QUALITY ASSURANCE

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

A. ASTM C 150, Portland Cement.

B. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).

C. ASTM C 191, Time of Setting of Hydraulic Cement by Vicat Needle.

D. CRD-C 588, Specifications for Non-Shrink Grout.

1.4 PRODUCT DELIVERY. STORAGE AND HANDLING

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Non-metallic, cartridge style, 100 percent solids, high strength epoxy grout.
1. Product and Manufacturer: Speed Bond #1 as manufactured by Prime Resins Inc.
2. Or Equal.

B. Non-Shrink, Non-Metallic Grout:
1. Pre-mixed non-staining cementious grout requiring only the addition of water at the jobsite meeting ASTM C-827 and CRD C-621.
2. Product and Manufacturer:
   a. Sikagrout 212 by Sika Corp.
   b. Masterflow 713 by Master Builders Company.
   c. Non-Ferrous Non-Shrink Grout by the Burke Company.
   d. Non-Shrink, Non-Metallic Grout as manufactured by W. R.Meadows.
   e. Or Equal.

C. Ordinary Cement-Sand Grout:
1. Except where otherwise specified use 1 part cement to 3 parts sand complying with the following:
   a. Cement: ASTM C 150, Type II.
   b. Sand: ASTM C 33.
2. For water repelling and shrinkage reducing requirements use admixtures.
   Product and Manufacturer:
   a. Integral Waterpeller by The Euclid Chemical Company.

b. Omicron, Type OM by Master Builders Company.
c. Hydrocide Powder by Sonneborn-Contech.
d. Or Equal.

3. For use at horizontal waterstops only.

D. Water:

Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalis or organic matter.

E. Epoxy Resin Adhesive:
1. Two part mix 1:1
2. Manufacturer: Sika Corp - Sikadur 32, Hi-Mod (Horizontal joints), Sikadur 31 Hi-Modgel (Vertical joints) or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until Engineer provides clarification.
2. Drypacking will not be permitted unless approved by the Engineer.
3. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
4. Placing grout shall conform to temperature and weather limitations in Section 03300.
5. Surface to be grouted is to be adequately cured, cleaned dampened and roughened per manufacturer recommendations to insure adequate bonding.

B. Pipe Railings:
1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.
2. Do not grout railing designated as "removable sections".

C. Grout for Dowelling and Anchor Bolts:
1. Grout shall be introduced at the bottom of the drill holes using a caulking tube or other injection means. The hole shall be blown out or pumped dry prior to the introduction of grout into the hole. Care shall be taken to adequately fill the hole with grout before the dowel or anchor rod is inserted, to insure complete contact with the anchor for its full length.

2. A plug shall be placed in the top of the hole to hold the bars securely until the grout sets. Special care shall be taken to insure against any movement of the bars which have been placed.
3. Epoxy resin Adhesive may be used in accordance with manufacturer's recommended application.

D. Grouting for Waterstops:
1. Grout for PVC waterstops to be the non-shrink, non-metallic type. Refer to Section 03250 for installation procedures.
2. Grout from Redi-mix plant conforming to applicable requirements of Section 03300 may be substituted at no additional compensation to the contractor.

E. Grouting for Weir and Slide Gates:

Provide minimum of 1" thickness of non-shrink, non-metallic grout under frames. Gates to be coated with an approved epoxy coating per Section 09900 prior to installing and grouting.

F. Grouting for Bearing Plates and Equipment:

Use non-shrink, non-metallic grout for setting bearing plates and equipment. Provide a minimum grout thickness of 1".

G. Patchwork at Demolition Areas:
1. Furnish and install non-shrink, non-metallic grout for dry packing as required to patch all mechanical, electrical and miscellaneous penetrations which are either designated to be patched or are the result of abandoned, removed or relocated material and equipment. Prepare surface and place grout as recommended by manufacturer and as specified. Finish grout off flush with existing surface.
2. Reinforce with approved wire mesh and use approved structural concrete for penetrations larger than 1/2 square feet. Conform to requirements of Sections 03100, 03200 and 03300.

END OF SECTION

SECTION 03930

REPAIR AND REHABILITATION OF CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to repair or rehabilitate, as required, all existing concrete shown or indicated in the Contract Documents as being repaired or rehabilitated.
   2. CONTRACTOR shall repair all damage to new concrete construction as specified in this Section except for repair Work specified in Section 03300, Cast-In-Place Concrete.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the Work that must be installed with or before repair and rehabilitation of concrete.
   2. Notify other contractors in advance of repair and rehabilitation of concrete Work to provide them with sufficient time for installing and coordinating items included in their contracts that must be installed in conjunction with repair and rehabilitation of concrete Work.

C. Related Sections:
   1. Section 01600, General Material and Equipment Requirements
   2. Section 03300, Cast-In-Place Concrete.
   3. Section 03600, Grout.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C109/C109M, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. ASTM C882/C882M, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. ASTM D1042, Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions.

4. ASTM D3574, Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams.
5. ASTM G109, Test Method for Determining the Effects of Chemical Admixtures on the Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Information on all products proposed for use, including manufacturer's brochures, technical data, specifications, and other applicable data.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions: Manufacturer's recommended procedures for installing materials proposed for use.

C. Special Procedure Submittals: When requested by ENGINEER, submit information on methods for supporting during demolition and repair Work existing structures, pipes, and other existing facilities affected by the Work.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling of Materials:
   1. Conform to Section 01600, General Material and Equipment Requirements, and this Section.
   2. Clearly mark on containers manufacturer's name and label, name or title of material, manufacturer's stock number, and date of manufacture.
   3. Handle materials carefully to prevent inclusion of foreign matter.
   4. Do not open containers or mix components until necessary preparatory Work has been completed and application Work is to start immediately.

B. Storage of Materials:
   1. Conform to Section 01600, General Material and Equipment Requirements, and this Section.
   2. Store only approved materials at the Site.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIRMENTS

A. All repair and rehabilitation materials that can or will come into contact with potable water or that will be treated to become potable shall be listed in ANSI/NSF 61.

2.2 REPAIR MORTAR

A. Product Description: Repair mortar shall be prepackaged, cement-based product specifically formulated for repairing concrete surface defects.

B. Products and Manufacturers: Provide one of the following:
1. SikaTop 122 Plus, SikaTop 123 Plus, or SikaTop 126 Plus, by Sika Corporation.
2. DuralTop Gel, DuralTop Flowable Mortar by Euclid Chemical Company.
3. Or equal.

C. Materials:
1. Provide a two-component, polymer-modified, Portland cement, fast-setting, trowel-grade mortar. Repair mortar shall be enhanced with penetrating corrosion inhibitor, and shall have the following properties:

Physical Property	Value	ASTM Standard
Minimum Compressive Strength at One Day	2,000 psi	C109
Minimum Compressive Strength at 28 Days	6,000 psi	C109
Minimum Bond Strength at 28 Days	1,800 psi	C882*
* Modified for use with repair mortars.		

2. Where the least dimension of the placement in width or thickness exceeds four inches, extend repair mortar by adding aggregate as recommended by repair mortar manufacturer.

2.3 EXPANSION JOINT REPAIR SYSTEM

A. System Description: Joint repair system shall consist of two components: an epoxy resin adhesive and hypalon sheeting

B. Products and Manufacturers: Provide one of the following:
1. Sikadur Combiflex, by Sika Corporation.
2. Or equal.

C. Materials:

1. Epoxy Resin Adhesive: Provide two-component epoxy resin as follows:
    a. Component “A” shall be modified epoxy resin of epichlorohydrin bisphenol-A type containing suitable viscosity control agents and pigments. Resin shall not contain butyl glycidyl ether.
    b. Component “B” shall be primarily a reaction product of selected amine blend with epoxy resin of epichlorohydrin bisphenol-A type containing suitable viscosity control agents, pigments, and accelerators.
2. Hypalon Sheeting:
    a. Provide sheeting of hypalon rubber, perforated along bonding edge to provide mechanical key. Sheeting shall have ability to be vulcanized with hydrocarbon solvent for adhesion to an epoxy resin adhesive.
    b. Provide sheeting in 12-inch width with thickness of 40 mils.
    c. Sheeting shall be able to be lapped or seamed by heat or by anaromatic hydrosolvent strip.
    d. Provide sheeting with removable center expansion strip.

2.4 REPAIR OF EXPOSED REINFORCING STEEL

A. System Description: System for repair of exposed reinforcing steel shall consist of two components: an initial application of corrosion inhibitor and subsequent application of protective slurry mortar.

B. Corrosion Inhibitor:
1. Corrosion inhibitor shall penetrate the hardened concrete surface and form a protective layer on reinforcing steel.
2. Products and Manufacturers: Provide one of the following:
    a. Sika FerroGard 903, by Sika Corporation.
    b. Or equal.
3. Corrosion inhibitor shall:
    a. Not change the substrate’s color, appearance, or texture.
    b. Penetrate independently of orientation (horizontal, vertical, overhead) at rate up to 1/10 to 4/5 inches per day, depending on density of concrete, measured using secondary neutron mass spectroscopy.
    c. Form on reinforcing steel a protective layer of high integrity of at least 100 angstroms thickness, measured using x-ray photon spectroscopy and secondary ion mass spectroscopy.
    d. Demonstrate reduction in corrosion currents after treatment as determined using cracked beam corrosion tests of concrete, as adapted from ASTM G109.

e. Be capable of reducing active corrosion rates by at least 65 percent. Reduction shall be demonstrated by project references and an independent corrosion engineer using linear polarization resistance.
f. Penetrate up to three inches in 28 days, measured using secondary neutron mass spectroscopy.

C. Protective Slurry Mortar:
1. Material shall be two-component, polymer-modified, cementious waterproofing and protective slurry mortar. Provide two coats at coverage of 50 square feet per gallon per coat.
2. Products and Manufacturers: Provide one of the following:
a. Sikatop Seal 107, by Sika Corporation.
b. Or equal.

2.5 CRACK INJECTION MATERIALS

A. Crack Repair System:
1. Hydrophobic Polyurethane Chemical Grout:
a. Provide hydrophobic polyurethane that forms a flexible gasket.
b. Products and Manufacturers: Provide one of the following:
1) SikaFix HH LV, by Sika Chemical Company.
c. Or equal.Shrinkage limit shall not exceed 4.0 percent in accordance with ASTM D1042.
d. Minimum elongation of 250 percent in accordance with ASTM D3574.
e. Minimum tensile strength of 150 psi in accordance with ASTM D3574.
2. Hydrophilic Acrylate-Ester Resin:
a. Hydrophilic crack repair system shall be acrylate-ester resin that forms a flexible gasket and increase in volume by at least 50 percent when in contact with water.
b. Products and Manufacturers: Provide one of the following:
1) Duroseal Multigel 850, manufactured by
2) BBZ USA, Inc.
3) Or equal

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which the repair Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation:

1. Initial Surface Preparation: Remove by chipping, abrasive blasting, or hydro blasting all laitance, foreign material, and unsound concrete from entire area to be repaired. Further roughen surface as specified in this Section. Where non-shrink grout or repair mortar is used, perform additional surface preparation, if any, recommended by product manufacturer.
2. Wetting Procedure: Where repair concrete, shotcrete, or cement grout is used, and bonding agent is not required, or where repair mortar or non-shrink grout manufacturer recommends wet or saturated surface, perform the following:
    a. Surface being repaired. Where large surface areas are to be repaired, use fog-spray nozzles, mounted on stands, in sufficient number so that entire surface to be repaired is contacted by fog spray cloud.
    b. Prevent concrete from drying until after repair is completed. Re-wet surfaces not yet repaired using water sprays at least a daily; should more than four days elapse without re-wetting surfaces not yet repaired, repeat the original saturating procedure.
    c. Remove standing water in areas to be repaired before placing repair material. Provide means to remove excess water from structure.
3. Preparation for Epoxy Bonding Agent: Where repair material manufacturer recommends use of epoxy-bonding agent, conform to recommendations of both repair material manufacturer and bonding agent manufacturer.

3.3 INSTALLATION, GENERAL

A. Construction Tolerances: Shall be as specified in Section 03300, Cast-In-Place Concrete, except as specified in this Section and elsewhere in the Contract Documents.

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

C. Bring surface being repaired into alignment with adjacent surfaces, providing uniform, even surface. Surface repaired shall match adjacent existing surfaces in texture and shall receive coatings or surface treatments, if any, provided for the existing surface adjacent to repaired surface.

D. Curing:

1. Curing of repair mortar and non-shrink grout shall be in accordance with manufacturer's recommendations, except that minimum cure period shall be three days.
2. Curing of other materials shall be in accordance with requirements of Section 03 30 00, Cast-In-Place Concrete.

3.4 REPAIR OF SURFACE DEFECTS

A. Surface defects are depressions in a concrete surface that do not extend all the way through the concrete. Surface defects can result from removal of an embedded item, removal of an intersecting concrete member, physical damage, or unrepaired rock pockets created during original placement. For spalls that result from corroded reinforcing steel or other embedment refer to Article 3.7 of this Section.

B. Preparation: Perform the following in addition to requirements of Article 3.2 of this Section:
1. Remove by chipping all loose, damaged concrete to sound material.
2. Where existing reinforcing is exposed, remove concrete to minimum of one-inch around exposed bars. If existing bars are cut through, cracked, or cross sectional area is reduced by more than 25 percent from original, immediately notify ENGINEER.
3. Score-cut perimeter of area to be repaired to minimum depth of 1/2-inch and maximum depth that will not cut existing reinforcing steel. Chip out existing concrete to the score line so that minimum thickness of repair mortar will be 1/2-inch.

C. Repair Material:
1. Completely fill the surface defect with specified repair material, in accordance with material manufacturer's instructions and the Contract Documents.
2. Perform, with repair mortar, repairs of surface defects in concrete normally in contact with water or soil, and interior surfaces of structures that contain water.
3. Repair of other surface defects may be by applying repair mortar, repair concrete, shotcrete, or cement grout, as appropriate.

3.5 PATCHING OF HOLES IN CONCRETE

A. For holes larger than 1/2inch diameter or equivalent area of hole, refer to the Drawings for reinforcing details.

B. Fill openings less than four inches in their least dimension with Class III non-shrink epoxy grout in accordance with Section 03600, Grouting.

C. Openings greater than four inches and less than 16 inches in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class I non-shrink grout in accordance with Section 03600, Grouting.

D. Openings greater than 16 inches in their least dimension shall be coated with an epoxy bonding agent prior to filling with Class D concrete in accordance with Section 03300, Cast-In-Place Concrete.

3.6 REPAIR OF LINED HOLES

A. This Article applies to openings with embedded material over all or a portion of inside surface of hole. Where indicated on the Drawings, remove embedded materials and repair the hole in accordance with Article 3.5 of this Section, as modified in this Article 3.6.

B. Where embedded material is allowed to remain, remove embedded material to at least two inches into the hole, as measured from the plane surface of concrete wall or slab, as applicable. Embedded material left in place shall be roughened or abraded for proper bonding to repair material. Completely remove substances that interfere with proper bonding.

C. Completely remove embedded items not securely and permanently anchored into concrete.

D. Completely remove embedded items larger than 12 inches in their smallest dimension. In lieu of removing the embedded item, where reinforcing is required as shown or indicated in the Contract Documents, weld reinforcing to embedded item to remain, provided embedded item to remain is composed of metal to which reinforcing steel can be welded.

3.7 REPAIR OF DETERIORATED CONCRETE

A. This Article pertains to deteriorated concrete which has been damaged due to corrosion of reinforcing steel, physical damage due to abrasion, or damage due to chemical attack. Use repair mortar, as specified in this Article, for repairing deteriorated concrete. Where repaired surface will be subsequently covered with plastic liner material, coordinate finishing with requirements for installing plastic liner material.

B. Surface Preparation: In addition to requirements of Article 3.2 of this Section, perform the following surface preparation:

1. Remove loose, broken, softened, and acid-contaminated concrete by abrasive blasting and chipping to sound, uncontaminated concrete.

2. Upon completion of removal of deteriorated concrete, notify ENGINEER in writing. Allow two weeks for ENGINEER to evaluate the surface, perform testing for acid contamination if required, determine if additional concrete shall be removed, and to develop special repair details (if any) required. Should ENGINEER determine that additional concrete be removed to reach sound, uncontaminated concrete, allow another two-week period for further evaluation and testing following the additional removal.
3. Surface preparation shall conform to recommendations of repair mortar manufacturer.
4. Repair and rehabilitate isolated areas of exposed reinforcing bars in accordance with Article 3.4 of this Section. If extensive areas of reinforcing steel are uncovered after removal of deteriorated concrete, ENGINEER will determine the repair methods required.

C. Repair Mortar Placing:
1. Conform to manufacturer's recommended procedures for mixing and placing repair mortar.
2. After initial mixing of repair mortar, addition of water is not allowed.
3. Minimum Thickness:
   a. Install repair mortar to not less than minimum thickness recommended by manufacturer, and not less than 1/2-inch.
   b. Where removal of deteriorated concrete results in repair thickness of less than minimum required thickness to return to original concrete surface in isolated areas totaling less than ten percent of total repair surface area, remove additional concrete to obtain at least the required minimum thickness.
   c. Where surface area with repair thickness less than minimum required thickness exceeds ten percent of total repair area, notify ENGINEER.
   d. Provide repair mortar so that minimum cover over existing reinforcing steel is two inches. Do not place repair mortar creating locally raised areas.
   e. Where transitioning to or from wall surfaces not requiring repair, do not feather-out repair mortar at transition. Instead, form the transition by saw cutting a score line to not less than minimum required repair mortar depth and chip out concrete to the saw cut line. Do not cut or otherwise damage reinforcing steel.
4. Place repair mortar to an even, uniform plane to restore concrete member to its original surface. Out-of-plane tolerance shall be such that the gap between 12-inch long straight edge and repair mortar surface does not exceed 1/8-inch, and gap between a four-foot long straight edge and repair mortar surface shall not exceed

1/4-inch. Tolerances specified in this paragraph apply to straight edges placed in any orientation at any location.

D. Finishing:
   1. Provide smooth, steel trowel finish to repair mortar.
   2. When completed, there shall be no sharp edges. Provide exterior corners, such as at penetrations, one-inch radius. Interior corners shall be square, except corners to receive plastic lining which shall be made with two-inch fillet in repair mortar.

3.8 REPAIR OF EXPANSION JOINTS

A. Surface Preparation: Remove the following from surfaces to be repaired: laitance, foreign material, and unsound concrete. Remove by chipping, abrasive blasting, or hydro blasting. Additional surface preparation, if required, shall be as recommended by expansion joint repair system manufacturer.

B. Installation: Installation shall be as recommended by expansion joint repair system manufacturer.

3.9 REPAIR OF EXPOSED REINFORCING

A. Remove, by abrasive blasting or hydro blasting, all corrosion, foreign materials, and unsound concrete from area to be repaired.

B. Surface shall be visually dry before applying corrosion inhibitor. Liberally apply corrosion inhibitor to achieve coverage of 100 square feet per gallon in two or more coats, by allowing corrosion inhibitor to soak into substrate. Time between coats shall be the longer of: one hour, or as recommended by corrosion inhibitor manufacturer. Apply using rollers, brushes, or hand-pressure spray equipment.

C. After applying final coat of corrosion inhibitor, minimum cure time of 24 hours is required.

D. Provide high-pressure wash to surfaces to be repaired to remove filmy residue from corrosion inhibitor.

E. For mortar coating, conform to Paragraphs 3.7.C, 3.7.D, 3.7.E of this Section.

3.10 CRACK INJECTION

A. Examine areas under which injection Work will be installed and locate cracks that require injection. Identify and inject cracks greater than 0.010-

inch wide in structures that retain or contain water, wastewater, or similar liquid.

B. Install injection material in accordance with crack injection manufacturer's requirements.

C. After injecting and curing, verify that injected material penetrated the crack adequately and that there is no visible leakage through the crack. After injecting, if crack continues to leak, re-inject crack at no additional cost to OWNER until structure is watertight.

D. If proper penetration of crack cannot be achieved, submit to ENGINEER a proposed alternate approach for modifying the specified injection procedure to properly seal the crack. In new concrete and in concrete cracked as a result of CONTRACTOR's operations, perform modifications to crack injection procedure and fully repair the crack without additional cost to OWNER or extension of the Contract Times.

3.11 SITE QUALITY CONTROL

A. OWNER will employ and pay for services of testing laboratory for Site quality control testing. ENGINEER will direct the number of tests and specimens required, including providing necessary materials for making and facility for storing test specimens. CONTRACTOR shall make standard compression test specimens as specified in this Section under the observation of ENGINEER. CONTRACTOR shall provide:
   1. Necessary assistance required by ENGINEER.
   2. All labor, material, and equipment required, including rods, molds, thermometer, curing in heated storage box, and all other incidentals required, subject to approval by ENGINEER.
   3. All necessary storage, curing, and transportation required for testing.
   4. CONTRACTOR will be charged for cost of additional testing and investigation, if any, for Work performed that is not in accordance with the Contract Documents or is otherwise defective.

B. Site Tests of Cement-based Grouts and Repair Mortar:
   1. Obtain compression test specimens during construction from first placement of each type of mortar or grout, and at intervals thereafter as selected by ENGINEER, to verify compliance with the Contract Documents. Specimens will be made by ENGINEER or ENGINEER's representative.
   2. Compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed in accordance with ASTM C109. Set of three specimens will be made for each test. Tests

will be made at seven days, 28 days, and additional time periods as deemed appropriate by ENGINEER.

3. Material, already placed, failing to conform to the Contract Documents, is defective.

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

END OF SECTION

DIVISION 4

MASONRY

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SECTION 04810
UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified and required for masonry Work, including:
a. Providing openings in unit masonry construction to accommodate the Work under this and other Specification Sections, and building into unit masonry construction all items such as sleeves, anchorage devices, inserts and other items to be embedded in unit masonry construction for which placement is not specifically provided under other Specification Sections.
b. Providing openings in unit masonry construction to accommodate the work under other contracts and assisting other contractors in building into unit masonry construction all items such as sleeves, anchorage devices, inserts, and other items required to be embedded in unit masonry construction under other contracts.
2. Extent of each type of unit masonry is shown.
3. Types of products and features required include:
a. Concrete unit masonry.
b. Masonry mortar and grout.
c. Masonry accessories.
d. Unit masonry meeting requirements of Special Inspections.
e. Disposal of Waste Material.

B. Coordination:
1. Review installation procedures under other Specification Sections and coordinate the items that must be installed with unit masonry construction Work.
2. Unit masonry construction done without built-in flashings and other built-in Work shall be removed and rebuilt at no additional cost to OWNER, even if discovered after apparent completion of unit masonry construction.
3. Coordinate Work under other Specification Sections to avoid delay of masonry construction.
4. Notify other contractors in advance of erecting unit masonry construction to provide other contractors with sufficient time to

provide items that must be installed with or before masonry construction.

C. Related Sections:
1. Section 05500, Miscellaneous Metals.
2. Section 07900, Caulking and Sealants.
3. Section 09900, Painting.

1.2 REFERENCES

Referenced Standards: Standards referenced in this Section are:
1. ACI 530, Building Code Requirements for Masonry Structures.
2. ACI 530.1, Specification for Masonry Structures.
3. ASTM A36, Standard Specification for Carbon Structural Steel.
4. ASTM A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
5. ASTM A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A615, Standard Specification for Deformed and Plain Carbon - Bars for Concrete Reinforcement.
7. ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
8. ASTM A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Low-Alloy with Improved Formability.
9. ASTM C5, Standard Specification for Quicklime for Structural Purposes.
10. ASTM C33, Standard Specification for Concrete Aggregates.
11. ASTM C67, Standard Test Method for Sampling and Testing Brick and Structural Clay Tile.
12. ASTM C90, Standard Specification for Hollow Load-Bearing Concrete Masonry Units.
13. ASTM C91, Standard Specification for Masonry Cement.
14. ASTM C62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale)
15. ASTM C129, Standard Specification for Non-loadbearing Concrete Masonry Units
16. ASTM C136, Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates.
17. ASTM C140, Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
18. ASTM C144, Standard Specification for Aggregate for Masonry Mortar.
19. ASTM C150, Standard Specification for Portland Cement.

20. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.
21. ASTM C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
22. ASTM C270, Standard Specification for Mortar for Unit Masonry.
23. ASTM C331, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
24. ASTM C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
25. ASTM C404, Standard Specification for Aggregates for Masonry Grouts.
26. ASTM C426, Standard Test Method for Linear Drying Shrinkage of Concrete Block.
27. ASTM C 652, Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
28. ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
29. ASTM C1019, Standard Test Method for Sampling and Testing Grout.
30. ASTM C1093, Practice for Accreditation of Testing Agencies for Unit Masonry.
31. ASTM C1314, Standard Test Method for Compressive Strength of Masonry Prisms.
32. ASTM D2240, Standard Test Method for Rubber Property-Durometer Hardness.
33. ASTM D2287, Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.
34. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
35. ASTM E119, Standard Test Method for Fire Tests of Building Construction and Materials.
36. BIA, Technical Notes on Brick and Tile Construction.
37. BIA, Technical Bulletin 1A, Construction and Protection Recommendations for Cold Weather Masonry Construction.
38. BIA, Technical Notes on Cleaning Clay Products Masonry.
39. NCMA, Guide Specifications and Technical Bulletins.
40. UL, Design No. U 901, Bearing Wall Rating – 4 HR.; Non-bearing Wall Rating –4 HR.
41. UL, Design No. U 902, Bearing Wall Rating – 4 HR., Alternative Detail.
42. UL, Design No. U 904, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating –3 HR.
43. UL, Design No. U 905, Bearing Wall Rating – 2 HR.; Non-bearing Wall Rating –2 HR.

44. UL, Design No. U 906, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating –2 HR.
45. UL, Design No. U 907, Nonbearing Wall Rating – 3 or 4 HR.
46. UL, Design No. U 909, Nonbearing Wall Rating – 3 or 4 HR.
47. UL, Design No. U 910, Bearing Wall Rating – 4 HR.; Non-bearing Wall Rating – 4 HR.
48. UL, Design No. U 912, Bearing Wall Rating – 3 HR.; Non-bearing Wall Rating 3 HR.
49. UL, Design No. U 913, Bearing Wall Rating – 2 HR.; Nonbearing Wall Rating –2 HR.
50. UL, Design No. U 914, Bearing Wall Rating – 3 HR.; Nonbearing Wall Rating –3 HR.
51. UL 901, Specification for Quicklime for Structural Purposes.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer: Hire a single installer regularly engaged in preformed unit masonry installation and with successful and documented experience in erecting unit masonry of scope and type of Work required; and employs only tradesmen with specific skill and successful experience in this type of Work. Submit name and qualifications to ENGINEER with the following information for at least three successful, completed projects:
      a. Names and telephone numbers of owners, architects, or engineers responsible for project.
      b. Approximate contract cost of unit masonry for which installer was responsible.
      c. Amount (square feet) of unit masonry installed.
   2. Laboratory Qualifications:
      Testing Laboratory: In accordance with ASTM C1093.

B. Component Supply and Compatibility:
   1. Obtain each type of concrete masonry unit from one Supplier, cured by one process and of uniform texture and color, or in an established uniform blend thereof.
   2. Do not change source or brands of mortar products during the Project.
   3. Where question of compliance to requirements of this Section arise, mortar properties Specification will take precedence over mortar proportion Specification.
   4. Do not change proportions established for mortar accepted under property Specifications, and do not use products with different physical characteristics in mortar used in the Work, unless compliance with requirements of property Specifications is re-established by submitting acceptable data to ENGINEER.

5. Do not combine two air-entraining materials in mortar.

C. Regulatory Requirements: Where fire-resistance classification is shown or scheduled for unit masonry construction (four-hour, three-hour, and similar designations), comply with applicable requirements for products and installation established by UL tests referenced in this Section and authorities having jurisdiction.

D. Job Mock-up:
1. Prior to installing unit masonry and after ENGINEER's approval of Samples, erect job mock-ups using products, pattern bond, and joint tooling shown or specified. Build mock-up at the Site, at a location approved by the ENGINEER, of full required wall thickness. Mock-up shall be approximately 4.0 feet by 3.33 feet unless another size or location is shown as job mock-up. Provide special features as directed, including finished opening 16 inches by 16 inches, finished end, and masonry control joint. Indicate proposed range of color, texture and workmanship to be expected in completed Work. Obtain ENGINEER's approval of visual qualities of mock-up before starting unit masonry construction. Retain and protect mock-up during construction as a standard for judging unit masonry Work. Do not alter, move, or destroy mock-up until receiving written permission by ENGINEER.
2. Build as many mock-up panels as required to obtain ENGINEER's approval.
3. Perform unit masonry construction tests per ACI 530.1. Provide to ENGINEER acceptable test results before starting masonry construction.
4. Masonry construction that does not meet standards approved on mock-up panel shall be removed and rebuilt to conform to the Contract Documents. Provide mock-up panel for the following:
   a. Typical complete interior partition of concrete unit masonry where both sides will remain visually exposed in finished Work.

E. Masonry Pre-installation Conference:
1. Prior to starting unit masonry construction Work, schedule and hold masonry pre-installation conference at the Site, to review foreseeable methods and procedures related to unit masonry Work including:
   a. Project requirements per the Contract Documents.
   b. Structural concept.
   c. Sequence of masonry construction.
   d. Special masonry details.
   e. Required submittals.
   f. Standard of workmanship.

g. Prism tests or mortar, grout sample and unit masonry tests results.
h. Quality control requirements.
i. Job organization and availability of products, tradesmen, equipment, and facilities needed to conform to Progress Schedule.
j. Masonry control and expansion joint location and materials.
k. Modular planning requirements.
l. Weather and forecasted weather conditions, and procedures for coping with unfavorable conditions.
m. Required special inspection, testing, and certifying procedures.
n. Compliance with building codes and other Laws and Regulations.
o. Disposal of Waste Material Plan requirements.

2. Attendance is mandatory for the following:
   a. CONTRACTOR's Site superintendent.
   b. Masonry Subcontractor's Site superintendent.
   c. Masonry Subcontractor's foreman.
   d. Authorized representative of unit masonry Suppliers.
   e. ENGINEER.
   f. Special Inspection Coordinator.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. CONTRACTOR shall record discussions of conference and decisions and agreements (or disagreements) and provide copy of record to each conference attendee.

1.4 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings: Submit the following:
      a. Complete layout of all masonry walls showing modular planning and all special shapes to be used in the Work. Show details for each condition encountered in the Work. Provide plan and elevation views drawn at a scale of 1/4-inch equal to 1.0 foot, and details drawn at a scale of 1.5-inch equal to 1.0 foot. Show all items included in unit masonry construction.
      b. Shop Drawings showing location, extent and accurate configuration and profile of all items shown, specified, and required by this and other Specification Sections included in unit masonry construction.
      c. Shop Drawing for fabrication, bending, and placement of reinforcing bars. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and

assemblies as required for fabricating and placing reinforcing for unit masonry Work.

d. Job Mock-up: Shop Drawings showing location, extent, and accurate configuration of all items to be built into the mock-up. Provide elevations drawn at scale of 1.5 inch equal to 1.0 foot.

2. Product Data: Submit the following:
   a. Copies of manufacturer's specifications and test data for each type of concrete masonry unit specified, including certification that concrete masonry unit complies with Contract Documents. Include instructions for handling, storage, installation and protection of each type of concrete masonry unit.
   b. Colored Mortar: Technical data on each type of colored mortar, including range of color that can be expected in the Work.
3. Samples: Submit the following:
   a. Color Sample board, for each type of unit masonry specified, showing standard and custom colors.
   b. Each type of unit masonry specified in colors selected by ENGINEER. Select each type of unit masonry to show range of color and texture that can be expected in the Work.
   c. Colored Mortar Samples: Submit complete selection of standard colors and custom colors of mortar for final selection by ENGINEER. Label Samples to indicate type and amount of colorant used.
   d. ENGINEER's review will be for color and texture only.

B. Informational Submittals:
1. Source Quality Control Submittals: Submit the following:
   Pre-construction laboratory test results, in accordance with ASTM C140.
2. Test and Evaluation Reports
   Preconstruction testing results as specified in Paragraph 3.1.B of this Section.
3. Sustainable Design Submittals: Submit the following:
   a. Disposal of Waste Material Plan, per specified requirements.
4. Qualification Statements:
   a. Testing laboratory.
   b. Installer.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling of Products:
Comply with Section 01610, Transportation and Handling.

B. Storage of Materials:
   1. Comply with General Conditions GC-32, Storage of Materials and Equipment.
   2. Maintain temperatures under cover so that masonry products are above 20 degrees F during installation.

1.6 JOB CONDITIONS

A. Temporary Facilities: Provide supplemental heat sources and equipment as required should CONTRACTOR desire to continue unit masonry Work in cold weather. Pay for fuel for supplemental heat.

B. Environmental Requirements:
   1. Do not perform unit masonry Work when air temperature is below 28 degrees F on a rising temperature, or below 36 degrees F on falling temperatures without providing temporary, heated enclosures, or without providing temporary heating or other precautions to prevent freezing.
   2. Do not use frozen products, and do not build upon frozen unit masonry Work.
   3. Remove and replace all unit masonry Work damaged by cold.

C. Protection:
   1. Protect unit masonry Work against freezing for at least 48 hours after being placed.
      a. For Mean Daily Air Temperatures of 40 degrees F to 32 degrees F: Protect unit masonry construction from precipitation for 48 hours after installation.
      b. For Mean Daily Air Temperatures of 32 degrees F to 25 degrees F: Completely cover unit masonry construction for 48 hours after installation.
      c. For Mean Daily Temperatures of 25 degrees F to 20 degrees F: Completely cover unit masonry construction with insulating blankets for 48 hours after installation of the masonry.
      d. For Mean Daily Air Temperatures of 20 degrees F and Below: Maintain unit masonry construction above 32 degrees F for 48 hours by enclosure and supplementary heating.
   2. When Work is not in progress, protect partially completed unit masonry construction against rapid heat loss and from water entering the masonry by covering the top of walls with a strong, waterproof, non-staining membrane. Extend the membrane at least two feet down both sides of wall and secure in place using wall cover clamps spaced at intervals of four feet and at each end, and at joints in membrane.

D. Cold Weather Unit Masonry Construction:

1. Mortar used in unit masonry construction when mean daily temperature is below 40 degrees F shall be Portland cement-lime-sand mortar using high early strength Portland cement.
2. Clay or shale unit masonry with suctions in excess of 20 grams of water per 30 square inches per minute shall be sprinkled with heated water just prior to installation. Provide water temperature above 70 degrees F when temperature of masonry units is above 32 degrees F. Water temperature shall be above 120 degrees F when temperature of masonry units is below 32 degrees F.
3. For Air Temperatures of 40 degrees F to 32 degrees F: Heat sand or mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
4. For Air Temperatures of 32 degrees F to 25 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F.
5. For Air Temperatures of 25 degrees F to 20 degrees F: Heat sand and mixing water to a minimum of 70 degrees F and maximum of 160 degrees F. Provide heat on both sides of the wall under construction. Employ wind breaks when wind is in excess of 15 mph.
6. For Air Temperatures of 20 degrees F and Below: Heat sand and mixing water to minimum of 70 degrees F and maximum of 160 degrees F. Provide enclosure and auxiliary heat to maintain air temperature above 32 degrees F in the work area. Temperature of masonry units when laid shall not be less than 20 degrees F.

E. Hot Weather Unit Masonry Work: Protect unit masonry Work by methods acceptable to ENGINEER from direct exposure to wind and sun when surrounding air temperature is 99 degrees F in the shade with relative humidity less than 50 percent.

PART 2 - PRODUCTS

2.1 MORTAR MATERIALS

A. Portland Cement: Provide the following for Portland cement-lime mortars:
1. ASTM C150, Type I.
2. Use ASTM C150, Type III high-early strength, for laying masonry when air temperature is less than 50 degrees F.
3. Provide nonstaining Portland cement of natural color.

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

C. Sand Aggregates:
1. ASTM C144, except for joints less than ¼-inch, use aggregate graded with 100 percent passing the No. 16 sieve.

2. White Mortar Aggregates: Provide natural white sand or ground white stone for Portland cement-lime mortars.
3. Colored Mortar Aggregates: Provide ground marble, granite, or other sound stone as required to match the sample approved by ENGINEER for Portland cement-lime mortars.
4. Fine Aggregate for Grout: Sand, ASTM C404, Size No. 1.
5. Course Aggregate for Grout: ASTM C404, Size No. 8 or Size No. 89.

D. Ready-mixed Mortar: Cementitious materials, water, and aggregate complying with requirements specified for mortar materials, combined with set-controlling admixtures to produce a ready-mixed mortar complying with ASTM C270 and C387.

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

2.2 MORTAR MIXES

A. General:
1. Anti-freeze Admixture or Agents: Not allowed.
2. Calcium Chloride: Not allowed.

B. Mortar for Unit Masonry: Comply with ASTM C270, Table 2, except limit materials to those specified in this Section, do not substitute ASTM C91 masonry cement for ASTM C150 Portland cement without a submittal approval by ENGINEER, and limit cement to lime ratio by volume as follows:
1. Type M:
   a. Provide following proportions by volume:
      1) Portland Cement: One part.
      2) Hydrated Lime or Lime Putty: 1/4 part.
      3) Aggregate Ratio (measured in damp loose condition): Not less than 2-1/4 and not more than three times sum of volumes of cementitious materials.
   b. Properties:
      1) Average Compressive Strength, ASTM C270: 2,500 psi.
      2) Minimum Water Retention, ASTM C270: 75 percent.
      3) Maximum Air Content, ASTM C270: 12 percent.
2. Fire-Resistant Mortar:
   a. Reference Standard: ANSI/UL BXUV U901 through BXUV U914.
   b. Proportion: Use one part portland cement, three parts clean sand, and 15 percent hydrated lime (by cement volume).

C. Grout:

1. Fine Grout:
    a. Provide the following proportions by volume:
        1) Portland Cement: One part.
        2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
        3) Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.
    b. Mix grout to have a slump of ten inches plus or minus one-inch at placement.
2. Coarse Grout:
    a. Provide the following proportions by volume:
        1) Portland Cement: One part.
        2) Hydrated Lime or Lime Putty: Zero to 1/10 part.
        3) Fine Aggregate Ratio (Measured in a Damp Loose Condition): Sand shall be not less than 2.25 times and not more than three times sum of volumes of cement and lime.
        4) Coarse Aggregate Ratio: Not less than one and not more than two times sum of volumes of cement and lime.
    b. Mix grout to have slump of ten inches plus or minus one-inch, at placement.

2.3 CONCRETE MASONRY UNITS

A. General: Concrete masonry units shall comply with requirements below.

B. Hollow and Solid Load-bearing Concrete Masonry Units: ASTM C90, with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of concrete mix.

C. Hollow Non-load-bearing Concrete Masonry Units: ASTM C129 with minimum of 15 percent coal fly ash and 50 percent recycle aggregate as part of the concrete mix.

D. Weight:
Provide lightweight hollow, load-bearing, concrete masonry units using aggregate complying with ASTM C331 producing dry net weight of not more than 105 pounds per cubic foot.

E. Size: Manufacturer's standard units with nominal face dimensions of 16 inches long by eight inches high by nominal width dimension shown on Drawings (15-5/8-inches by 7-5/8-inches actual).

F. Special Shapes: Provide the following:

1. Lintels, bond beams, reinforcing units, and flush-end reinforcing units, interior and exterior corner shapes, solid jambs, sash block, coves, pre-molded control joint blocks, headers, and other special conditions.
2. Bullnose units for outside vertical corners including doors, windows, louvers and other openings, unless specifically shown by note indicating that this feature is not required.
3. End blocks at all locations where masonry walls abut concrete, or steel columns to facilitate installation of compressible filler, backer rod and sealant or fire-rated fire stop sealant systems, if required.

G. Waterproofing Admixture: Manufacture all types of concrete unit masonry, used in construction of exterior walls (including interior wythe of cavity walls) with an integral waterproofing admixture as follows:
1. Material: Cross-linking acrylic polymer.
2. Proportion: In strict accordance with manufacturer's instructions.
3. Products and Manufacturers: Provide products of one of the following:
a. Dry-Block System by Forrer Industries, a Unit of W. R. Grace & Company Construction Products Division.
b. Eucon Blocktite by Euclid Chemical Company.
c. Or equal.

H. Exposed Faces: Provide manufacturer's standard color and texture.

I. Provide two-core concrete masonry units.

J. Provide concrete masonry units meeting requirements of the Special Inspections.

2.4 MASONRY ACCESSORIES

A. Continuous Horizontal Wire Reinforcing and Ties for Masonry: Provide the following unless otherwise shown:
1. General: Welded wire units prefabricated in straight lengths of not less than ten feet, with matching corner "L" and intersection "T" units. Fabricate from cold-drawn steel wire complying with ASTM A82, with deformed continuous 3/16-inch gage side rods and plain 9 gage cross rods, crimped for cavity wall construction, with unit width of 1.5 to two inches less than thickness of wall or partition. All reinforcing and ties shall be hot dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153, Class B-2, unless otherwise specified.
2. For single-wythe masonry, use units fabricated as follows:

a. Truss-type fabricated with one horizontal rod beneath each unit masonry shell wall and continuous diagonal cross-rods spaced not more than 16 inches on centers.

b. Products and Manufacturers: Provide one of the following:

1) #120 Truss-Mesh for 8" block by Hohmann and Barnard, Inc.

2) Series 300 Single Wythe System for 8" block by Wire-Bond.

3) DA 3100 Truss for 8" block by Dur-O-Wall, a Dayton Superior Company.

4) Or equal.

B. Anchoring Devices for Masonry: Provide the following, unless otherwise shown:

1. General: Provide the following:

a. Cold rolled steel sheet complying with ASTM A1008, hot-rolled steel sheet and strip complying with ASTM A1011, plates and bars complying with ASTM A36 and cold drawn steel wire complying with ASTM A82, all hot-dipped galvanized after fabrication with 1.5 ounces per square foot of zinc coating complying with ASTM A153.

b. Rectangular, corrugated, one-inch wide ties, fabricated of 12-gage sheet metal, unless otherwise specified.

c. Size tie lengths to extend to within one-inch of outside face of outer wythe face shell of opposite face of masonry or to maximum depth of 12 inches and between 1.5 inches to two inches less than width of masonry abutting webs and to a maximum depth of 12 inches abutting flanges of structural supports. Provide wire crimped with a vee-drip for use in cavity wall construction.

d. Flexible Anchors: When masonry abuts structural walls or framework provide flexible anchors that allow horizontal and vertical movement of masonry, but provide lateral restraint.

2. Anchorage to Cast-in-place Concrete Walls, Columns and Spandrels: Provide the following for lateral restraint of unit masonry walls abutting cast-in-place concrete members:

a. Triangular-shaped ties, fitted with 12-gage dovetail attachments, fabricated of 3/16-inch diameter wire with parallel overlapping ends, spaced not more than 16 inches on centers.

b. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each triangular-shaped tie, 3/16-inches high with four horizontal snap-tight connection grooves, one accommodating nine-gage wire and three accommodating 3/16-inch diameter wire.

c. Continuous, nine-gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry.

d. Products and Manufacturers: Provide products of one of the following:

1) No. 315-BT/Seismiclip/Continuous Wire - Flexible Dovetail Ties, Custom No. 302W(fitted with flexible dovetail attachment) - Column Web Ties and No. 305 - Dovetail Slot by Hohmann & Barnard, Inc.

2) No. 370 Seismic Hook Tab, No. 103 Wire Tie with Dovetail Attachment, No. 100 Dovetail Anchor, with Continuous Wire by Heckmann Building Products.

3) DA 720 Series - Seismic Dovetail Triangular Ties with DA 8706 Pencil Rod and DA 100 Dovetail Anchor Slot by Dur-O-Wal, a Dayton Superior Company.

4) Or equal.

3. Anchorage to Steel Columns and Steel Beam Webs: Provide the following for lateral restraint of unit masonry walls at structural steel framework:

a. Weld-on, 12-gage, 3/4-inch wide by seven-inch long anchor straps providing four inches of vertical adjustment, welded to steel structure.

b. Triangular-shaped ties fabricated of 3/16-inch diameter wire with parallel overlapping ends, spaced not more than 16 inches on centers.

c. Rigid, polyvinylchloride or 22-gage steel seismic restraint clips, one for each triangular-shaped tie, 3/16-inches high with four horizontal snap-tight connection grooves, one accommodating nine-gage wire and three accommodating 3/16-inch diameter wire.

d. Continuous, nine-gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry.

e. Products and Manufacturers: Provide products of one of the following:

1) Byna-Tie - Flexible Anchors/Seismiclip/Continuous Wire, No. 301W - Column Web Ties and No.359F Series - Anchor Straps by Hohmann & Barnard, Inc.

2) No. 370 Seismic Hook, No. 318 Triangle Ties, Custom No. 315 Weld-On Strap by Heckmann Building Products.

3) Or equal.

4. Anchorage to Steel Columns and Steel Beam Webs Receiving Thick Fireproofing: Provide the following for lateral restraint of unit masonry walls at fireproofed structural steel framework:

a. Weld-on, 3/8-inch diameter, nine-inch long ties welded to steel structure. Provide 1/4-inch thick backplates for compression restraint.
b. Wire column web ties.
c. Triangular-shaped ties fabricated of 3/16-inch diameter wire with parallel overlapping ends, spaced no more than 16 inches on centers.
d. Rigid, polyvinylchloride or 22-gage steel, seismic restraint clips, one for each triangular-shaped tie, 3/16-inches high with four horizontal snap-tight connection grooves, one accommodating nine-gage wire and three accommodating 3/16-inch diameter wire.
e. Continuous, nine-gage wire snap-locked into seismic restraint clips for embedment in outer veneer wythe of masonry.
1) Byna-Tie - Flexible Anchors/Seismiclip/Continuous Wire, #302 - Column Web Tie and #359FP Series with Backplates - Weld-On Tie and Compression Restraint Plates by Hohmann & Barnard, Inc.
2) No. 370 Seismic Hook Tab with Weld-On Tie and Compression Restraint Plates, No. 318 Wire Tie, No. 315 Anchor Rod, with Continuous Wire by Heckmann Building Products.
3) Or equal.

5. Compressible Filler: Provide watertight joint filler where unit masonry construction abuts structural framework members, or as shown. Provide the following:
a. Polyurethane foam strip saturated with polybutylene waterproofing material which, when installed at a compression ratio of two-to-one, is impermeable to water.
b. Resilient to -40 degrees F with 100 percent movement recovery.
c. Elongation of 140 percent with a tensile strength of not less than 53 pounds per square inch.
d. Products and Manufacturers: Provide products of one of the following:
1) Polytite Standard by Polytite Manufacturing Corporation.
2) Polyseal by Sandell Manufacturing Company, Inc.
3) Or equal.

C. Miscellaneous Masonry Accessories: Provide the following, where shown:
1. Reinforcing Bars:
Deformed carbon steel, ASTM A615, Grade 60 for bars No. 3 to No. 18 except as otherwise shown.
2. Rebar Positioners: Provide the following:

a. Nine-gage reinforcing bar positioners that accommodate both horizontal and vertical reinforcing steel.
b. Fabricate units as required for the Work.
c. Products and Manufacturers: Provide products of one of the following:
1) #RB Series and #RB-Twin Series Rebar Positioners by Hohmann & Barnard, Inc
2) Rebar Positioners by Heckmann Building Products.
3) Or equal.

3. Masonry Control Joint Components: Provide the following:
a. Pre-molded Control Joint Strips: Provide complete selection of solid extruded rubber and PVC strips with a Shore A durometer hardness of 80 to 90 complying with ASTM D2240 and D2287, designed to fit standard sash block and maintain lateral stability in masonry wall. Size and configuration shall be as shown.
1) Products and Manufacturers: Provide products of one of the following:
a) #RS-8 - Control Joints by Hohmann & Barnard, Inc.
b) #352-12 Control Joints by Heckmann Building Products.
c) Or equal.

2.8 SOURCE QUALITY CONTROL

Allowable Tolerances: For concrete masonry units provide the following:

A. Face Dimension: Total variation in finished and installed face dimensions of units shall not exceed 1/16-inch between largest and smallest units in each lot of units of each size.

B. Distortion: Distortion of plane and edges of face of individual units, as installed, from corresponding plane surface and edges of prefaced concrete masonry unit, shall not exceed 1/16-inch.

C. Top and Bottom Surfaces: Ground to provide finish height of 7-5/8 inches plus or minus 1/16-inch.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR and installer shall examine areas and conditions under which unit masonry construction Work will be installed, and notify

ENGINEER of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Preconstruction Testing: Testing agency shall perform tests prior to installation of unit masonry. Special inspections testing procedures are specified in the referenced standards and the Contract Documents.
   1. Mortar Test: For each mix required, per ASTM C780.
   2. Grout Test: For each mix required, per ASTM C1019 and ACI 530.1.
   3. Prism Test: For each type of construction required, per ASTM C 1314 and ACI 530.1.
   4. Compressive strength of completed concrete unit masonry walls shall not be less than 1,500 psi as determined by methods specified in ACI 530.1.

3.2 PREPARATION

A. Measurement of Mortar Materials:
   1. Cement and Hydrated Lime: Batched by the bag.
   2. Sand: Batched by volume in suitably calibrated containers, provided proper allowance is made for bulking and consolidation and for weight per cubic foot, of contained moisture.
   3. Proportion of Volumetric Mixtures: One 94-pound sack of Portland cement and one 50-pound sack of hydrated lime constitute nominal one cubic foot.
   4. Shovel measurement: Not allowed.

B. Mortar Mixing:
   1. Type of Mixer: Machine mix in approved mixer in which quantity of water is accurately and uniformly controlled.
   2. While mixer is in operation add approximately three-quarters of required water, half the sand, all the cement, then add remainder of sand.
   3. Allow batch to mix briefly then add water in small quantities until satisfactory workability is obtained.
   4. Mix for at least five minutes after all materials have been added.
   5. Hydrated Lime for Mortar Requiring Lime Content: Use dry-mix method. Turn over materials for each batch together until even color of mixed, dry materials indicates that cementitious material has been thoroughly distributed throughout mass, then add water to obtain required plasticity.
   6. Lime putty, if approved for use, shall be prepared in accordance with ASTM C5.
   7. Mixer drum shall be completely emptied before recharging next batch.
   8. Re-tempering of mortar is not allowed.

C. Wetting of Masonry Units:

1. Face Brick: Wet brick having ASTM C67 absorption rates in excess of 30 grams per 30 square inches per minute, so that rate of absorption when laid does not exceed this amount.
   Determine absorption by placing 20 drops of water using a medicine dropper inside one-inch diameter circle on typical units. If water is absorbed within 90 seconds, wet brick before laying.
2. Use wetting methods that ensure that each masonry unit is nearly saturated but surface-dry when laid.
3. Concrete Masonry Units: Except for absorbent units specified to be wetted, lay masonry units dry. Do not wet concrete masonry units.

D. Cleaning Reinforcement: Before being placed, remove loose rust, mill scale, earth, ice, and other coatings except galvanizing from reinforcement. Do not use reinforcing bars with kinks or bends not shown on Drawings or approved Shop Drawings, or bars with reduced cross-section.

3.3 INSTALLATION, GENERAL

A. Thickness: Build walls, floors and other unit masonry construction work to thickness shown. Build single-wythe walls to actual thickness of masonry units using units of nominal thickness shown or specified.

B. Build chases and recesses as shown or required by others. Provide at least eight inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

C. Leave openings for equipment, piping, ducts, and other items to be installed subsequent to start of masonry Work. After installing said items, complete unit masonry Work to match Work immediately adjacent to openings.

D. Cut masonry units using wet cutting, motor driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide pattern shown and to fit adjoining Work neatly. Use full size units without cutting wherever possible.

E. Match Existing Masonry: Match coursing, pattern bond, color, texture and size of new unit masonry with adjacent, existing masonry.

3.4 LAYING MASONRY WALLS

A. General:

1. Mortar Types: Unless otherwise indicated, use mortar as specified and as follows:
    a. For all Work, use Type M mortar.
    b. Use coarse grout fill for structural requirements and for grouting reinforcing steel in unit masonry construction Work.
    c. Do not use mortar that has begun to set or if more than 30 minutes have elapsed since initial mixing. Re-temper mortar during the 30-minute period only as required to restore workability.
2. Lay out walls in advance for accurate spacing of surface pattern bond with uniform joint widths and to properly locate openings, masonry control joints, returns, and offsets. Avoid using less than half-size units at corners, jambs, and where possible at other locations.
3. Lay up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced, and coordinated with other Work.
4. Pattern Bond Unit Masonry:
    a. Lay all unit masonry Work visible in the finished Work in running bond with vertical joints in each course centered on units in courses above and below. Avoid using less than full-size units.
    b. Bond and interlock each course of each wythe at corners.
    c. Do not use units with less than eight-inch horizontal face dimensions at corners or jambs.
    d. Interlock alternate courses at corners.
5. Color of Concrete Unit Masonry:
    a. Lay all concrete unit masonry of natural color.
    b. Lay all concrete unit masonry of colors as shown.

B. Construction Tolerances:

1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed 1/4-inch in 10 feet, or 3/8-inch in a story height (20 feet maximum), nor two-inch in 40 feet or more. Except for external corners, expansion joints and other conspicuous lines, do not exceed 1/4-inch in any story or 20 feet maximum, nor two-inch in 40 feet or more.
2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
3. Variation of Linear Building Line: For position shown and related portion of columns, walls and partitions, do not exceed two-inch in any bay or 20 feet maximum, nor 3/4-inch in 40 feet or more.
4. Variation in Cross-sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4-inch nor plus two-inch.

C. Mortar Bedding and Jointing:

1. Lay solid masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.
2. Lay hollow masonry units with full mortar coverage on horizontal and vertical face shells. Bed webs in mortar in starting course of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.
   Maintain joint widths shown, except for minor variations required to maintain pattern bond alignment. Lay walls with 3/8-inch joints.
3. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, except paint, unless otherwise shown.
4. Tool exposed joints, when mortar is "thumbprint" hard, slightly concave. Rake out mortar in preparation for application of calking or sealants where required.
5. Concave-tool exterior joints below grade.
6. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

D. Stopping and Resuming Work: Rake back half-unit masonry length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, if required, and remove loose masonry units and mortar prior to laying new masonry.

E. Built-in Work:

1. As the Work progresses, build in items shown, specified or required by others. Fill cores in one block width solidly with masonry around built-in items.
2. Where built-in items are to be embedded in cores of hollow masonry units, place layer of cavity fill mesh in joint below and rod mortar or grout into core.

F. Horizontal Joint Reinforcing:

1. Provide continuous horizontal joint reinforcing as specified. Fully embed longitudinal side rods in mortar for their entire length with minimum cover of 5/8-inch on exterior side of walls and 1/2-inch at other locations. Lap reinforcement minimum of six inches at ends of units. Do not bridge masonry control joints with reinforcing.
2. Reinforce all masonry walls with continuous horizontal joint reinforcing unless specifically noted or specified to be omitted.
3. Provide continuity at corners and wall intersections by use of prefabricated “L” and “T” sections. Cut and bend units in accordance with manufacturer’s written instructions.

4. Space continuous horizontal reinforcing as follows:
   Space reinforcing at 16 inches on centers vertically, unless otherwise shown.
5. Reinforce masonry openings greater than 12 inches wide, with horizontal joint reinforcing placed in two horizontal joints approximately eight inches apart, immediately above lintel and immediately below sill. Extend reinforcing minimum of 2.0 feet beyond jambs of opening.
6. In addition to wall reinforcing, provide additional reinforcing at openings as required to comply with the Contract Documents.

G. Structural Reinforced Unit Masonry Construction:
Comply with the requirements of ACI 530.1 and applicable codes.

H. Grouting Structural Reinforced Unit Masonry Construction:
Comply with requirements of ACI 530.1 and applicable codes.

I. Anchoring Masonry Work:
1. Provide anchoring devices of type specified. If not shown or specified, provide standard type for facing and back up involved in compliance with requirements of Laws and Regulations.
2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
   a. Provide an open space not less than 1/2-inch or more than one-inch in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar and other rigid materials.
   b. Anchor masonry to cast-in-place concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips and with triangular ties fitted with flexible dovetails for anchorage to cast-in-place concrete.
   c. Space anchors as shown, but not more than 2.0 feet on center vertically and 3.0 feet on center horizontally.
   d. Provide end blocks where masonry abuts structural support to facilitate installation of compressible filler, firesafing insulation, backer rod, and sealant.
3. Anchor single wythe masonry veneer to backing with metal ties as follows:
   a. Anchor veneer to structural members with metal anchors embedded in masonry joints and attached to structure. Provide anchors with flexible tie section, unless otherwise shown.
   b. Anchor veneer to concrete and structural steel members using continuous wire ties embedded in mortar and snap-locked into seismic clips with triangular ties, fitted with flexible

dovetails for anchorage to cast-in-place concrete, snap-locked to seismic clip and attached to structural supports using anchors specified.

c. Space anchors as shown, but not more than 2.0 feet on center vertically and 3.0 feet on center horizontally.

J. Masonry Control and Expansion Joints:

1. Provide vertical control and expansion joints in masonry where shown. Build in related items as unit masonry Work progresses. Rake out mortar in preparation for application of compressible filler, calking and sealants.
2. Masonry Control and Expansion Joints Items: Build in sash block and premolded control joint strips as the Work progresses.

K. Lintels and Bond Beams:

1. Provide masonry lintels and bond beams where openings of 16 inches or more are shown. Provide formed in place masonry lintels and bond beams. Temporarily support formed-in-place lintels and bond beams.
   a. Unless otherwise shown, provide one horizontal number six deformed reinforcing bar for each 4 inches of wall thickness.
   b. For hollow masonry unit walls, use specially formed "U"-shaped lintel and bond beam units with reinforcing bars placed as shown, filled with coarse grout as specified.
2. Provide minimum bearing at each jamb of eight inches for all openings.
3. On concrete unit masonry walls where pattern bond remains visually exposed, increase minimum bearing of masonry lintels to maintain joint pattern of wall and install to be indistinguishable from surrounding masonry.

L. Flashing of Masonry Work:

1. Provide concealed flashings in masonry Work as shown. Refer to Section 07620, Flashing and Trim, for type of flashing required. Prepare masonry surfaces smooth and free from projections which might puncture flashing. Place through-wall flashing on bed of mortar and cover with mortar. Seal flashing penetrations with mastic before covering with mortar. Terminate flashing two inches from face of wall, unless otherwise shown. Extend flashing at steel lintels in opening heads and turn down.
   a. Extend flashings beyond edge of lintels and sills at least 4 inches and turn up edge on sides, to form pan (end dam), to direct moisture to exterior.
   b. Interlock end joints of deformed metal flashings by overlapping deformations not less than 1.5 inches and seal lap with elastic sealant.

c. Seal joints in through wall metal flashing water tight.
d. Install flashings in accordance with manufacturer's instructions.

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

3.5 REPAIR, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes, except weep holes, and completely fill with mortar. Point up all joints at corners, openings and adjacent Work to provide neat, uniform appearance, properly prepared for application of sealant compounds.

C. Cleaning Exposed, Unglazed Masonry Surfaces:

1. Final Cleaning: After mortar is thoroughly set and cured, clean sample wall area of approximately 20 square feet as described below. Obtain ENGINEER's acceptance of sample cleaning before proceeding to clean remainder of masonry Work.
   a. Dry-clean to remove large particles of mortar using wood paddles and scrappers. Use chisel or wire brush if required.
   b. Presoak wall by saturating with water and flush off loose mortar and dirt.
   c. Comply with requirements and recommendations for "Cleaning Clay Products Masonry" of Technical Notes on Brick and Tile Construction by Brick Industry Association for type of masonry and conditions involved in the Work.
   d. Apply cleaners per manufacturer's instructions.
   e. Protect other Work from cleaning solutions and cleaning operations.
2. Do not use acid cleaning agent, abrasive tools or powders, or metal cleaning tools or wire brushes, unless specifically recommended in writing by manufacturer.

D. Protection: Protect unit masonry construction Work from deterioration, discoloration or damage during subsequent construction operations.

3.6 FIELD QUALITY CONTROL

Tests and Inspections:

A. Pre-construction Testing:

1. OWNER will employ a testing laboratory to perform field quality control testing in accordance with Section 01416, Testing Laboratory Services Furnished by Owner. Coordinate with testing laboratory to assist them in obtaining samples to conduct the following tests prior to the start of installation of unit masonry construction:
    a. Mortar Test: For each mix required: ASTM C780.
    b. Grout Test: For each mix required: ASTM C1019 and ACI 530.1.
    c. Prism Test: For each type of construction required: ASTM C1314 and ACI 530.1.
    d. Compressive strength of completed concrete unit masonry walls shall be at least 1,500 psi as determined by methods in ACI 530.1.
2. Obtain ENGINEER's acceptance of tests results prior to commencing installation of materials.
3. After initial test, ENGINEER will require performance of up to five additional tests ENGINEER's discretion.

B. During and After Installation:
1. Owner will employ testing laboratory to perform field quality control testing for masonry.
2. Comply with section 01416, Code-Required Special Inspections and Procedures.
3. Test and inspect unit masonry during construction in accordance with quality assurance program defined in ACI 530, ACI 530.1 and Laws and Regulations in effect at the Site, including building code.

C. Repair masonry walls that do not comply with requirements of the special inspections in a manner acceptable to ENGINEER.

3.7 DISPOSAL OF WASTE MATERIAL

Refer to Section SC-5, Disposal of Waste Material.

+++ END OF SECTION +++

DIVISION 5
METALS

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SECTION 05051

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ACI 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
   5. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
   6. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   7. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   8. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   9. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   10. ASTM A1011/A1011M, 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.
   11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   12. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

13. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
14. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
15. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
16. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
17. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
18. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
19. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
20. FS A-A-1923A, Concrete Expansion Anchors.
21. FS A-A-1925A, Shield, Expansion (Nail Anchors).
22. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
23. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
24. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
25. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
26. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
27. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer:
      a. Mechanical Anchors: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.
      b. Adhesive Anchors: Installation shall be performed by personnel certified under an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for ENGINEER's approval and shall be accepted by the building official having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
      b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.
   3. Samples:
      a. Representative Samples of anchor systems proposed for use in the Work. Review will be for type and finish only. Compliance with all other requirements is CONTRACTOR's exclusive responsibility.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
      c. For each adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:
      a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
      b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
   3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria
   1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
      a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
      b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.
2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.
3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
   a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
   b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
   c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled

with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.

d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:

1. Anchor Bolts:
   a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
   b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
2. Concrete Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Suitable for use in submerged, intermittently submerged, or buried locations.
   e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
   f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
3. Concrete Masonry Adhesive Anchors:
   a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
   b. Suitable for use where subject to vibration.
   c. Suitable for use in exterior locations or locations subject to freezing.
   d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
4. Concrete Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in concrete.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
   d. Do not use in submerged, intermittently submerged, or buried locations.
   e. Suitable for use in overhead applications.
5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.

b. Do not use where subject to vibration.
c. Do not use in exterior locations or locations subject to freezing.

6. Hollow Concrete Masonry Sleeve Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use at submerged, intermittently submerged, or buried locations.
   e. Do not use in exterior locations or locations subject to freezing.
   f. Suitable for use in overhead applications.
8. Concrete Undercut Anchors:
   a. Use where undercut anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Do not use in submerged, intermittently submerged, or buried locations.
   d. Do not use in exterior locations or locations subject to freezing.
   e. Suitable for use in overhead applications.
9. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
10. Drive-In Expansion Anchors:
    a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.
    b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
    c. Do not use in overhead applications.

2.2 MATERIALS

A. Anchor Bolts:
   1. Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
   2. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
   3. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
   1. General:
      a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-RE 500 V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      b. HIT-HY 200-A and HIT-HY 200-R Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
      c. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308, which incorporates the requirements of ACI 355.4-11.
      c Adhesives shall have minimum bond strength in accordance with Table 05 05 33-A:

TABLE 05 05 33-A:
ADHESIVE BOND STRENGTH [1,2]

Bond Strength (psi)					
Rod Diameter	**Uncracked Concrete**	**Cracked Concrete**	**Dowel Size**	**Uncracked Concrete**	**Cracked Concrete**
1/2-inch	1670	880	#5	1500	1080
5/8-inch	1670	750	#6	1460	1090
3/4-inch	1670	665	#7	1415	1015
7/8inch	1525	610	#8	1370	835

1-inch	1360	595	#9	1330	760
-			#10	1560	850
1.25-inch	1070	595	#4	1240	475

Table Notes:
1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 130 degrees F and maximum long term concrete temperature of 110 degrees F.

4. Anchor:
   a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Masonry Adhesive Anchors:
   1. General:
      a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
      b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
   2. Products and Manufacturers: Provide one of the following:
      a. HIT-HY 70 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
      b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Adhesive:
      a. Adhesive system shall use two-component adhesive mix.
      b. Hybrid adhesives shall comply with the following:
         1) ASTM D695 compressive yield strength greater than 7,200 psi on a seven-day cure.
      c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58 and ICC-ES AC 60.
   4. Anchor:
      a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
   5. Mesh Screen Tube (for hollow masonry applications):

a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.

D. Concrete Wedge Expansion Anchors:
   1. General:
      a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
   2. Products and Manufacturers: Provide one of the following:
      a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
      b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
   4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 304 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
   6. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

E. Grout-filled Masonry Wedge Expansion Anchors:
   1. General:
      a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
   2. Product and Manufacturers: Provide one of the following:
      a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
      b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
   4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   5. Other Locations: Provide AISI Type 316 stainless steel anchor, complete with nut and washer, in accordance with ASTM A276 or ASTM A493.

6. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.

F. Hollow Concrete Masonry Sleeve Expansion Anchors:
   1. General:
      a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.
   2. Products and Manufacturers: Provide one of the following:
      a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
      b. Dynabolt Sleeve Anchors, by ITW Red Head.
      c. Or equal.
   3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
   4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 304 stainless steel, in accordance with ASTM A276 or ASTM A493.

G. Drop-in Expansion Anchors:
   1. General:
      a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
   2. Products and Manufacturers: Provide one of the following:
      a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
      b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
      c. Or equal.
   3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

H. Concrete Undercut Anchors:
   1. General:
      a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
   2. Products and Manufacturers: Provide one of the following:
      a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.

b. Or equal

3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.
5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

I. Concrete Inserts:
1. Manufacturers: Provide products of one of the following:
   a. Unistrut Corporation.
   b. Cooper B-Line, Inc.
   c. Anvil International, Inc.
   d. Or equal.
2. Spot Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
4. Provide inserts with plain finish.

J. Drive-In Expansion Anchors:
1. General:
   a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
2. Products and Manufacturers: Provide one of the following:

a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
c. Or equal.

3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

K. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

L. Anti-Seizing Compound:
1. Products and Manufacturers: Provide one of the following:
a. Pure Nickel Never-Seez, by Bostik.
b. Nickel-Graf, by Anti-Seize Technology.
c. Or equal.
2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Anchor Bolts:
1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
3. Protect threads and shank from damage during installation and subsequent construction operations.
4. Unless otherwise shown or approved by ENGINEER anchor bolts shall comply with Table 05 05 33-B:

TABLE 05 05 33-B:
SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter	F1554 Grade 36	F1554
	F593 Type 316, Condition A	Grade 55

	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	947	1,815	8.5	12.75	1,245	2,393
5/8	7.5	11.25	1,508	2,895	10.5	15.75	1,980	3,810
3/4	9	13.5	2,231	4,290	13	19.5	2,933	5,640
7/8	10.5	15.75	3,080	5,918	15	22.5	4,050	7,793
1	12	18	4,040	7,770	17	25.5	5,318	10,088
1 1/8	13.5	20.25	5,090	9,789	19	28.5	8,930	12,435
1.1/4	15	22.5	6,463	12,429	21	31.5	8,505	15,030

Table Notes:

1. Table is based on ACI 318 and ACI 350, Appendix D, f'_c = 4000 psi. Table 05 05 33-B is not applicable to anchor bolts embedded in grouted masonry.
2. Critical edge distance and spacing are indicated in the table. Capacity of anchor bolts for other combination of edge distances and spacing shall be evaluated in accordance with ACI 318 and ACI 350, Appendix D.
3. Values for shear and tension listed are not considered to act concurrently. Interaction of tension and shear will be evaluated by ENGINEER in accordance with ACI 318 and ACI 350, Appendix D.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
   1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
   1. Comply with manufacturer's written installation instructions and the following.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
   3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
   4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
   5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.

6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
    a. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 2,500 psi.
    b. At time of anchor installation, concrete shall have age of not less than 21 days.
    c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
    d. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
    e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
1. Comply with expansion anchor manufacturer's written installation instructions and the following:
2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.
3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.

4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:
1. Comply with undercut anchor manufacturer's written installation instructions and the following.
2. Protect threads from damage during anchor installation.
3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
5. Insert the anchor by hand until anchor reaches bottom of hole.
6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
7. Verify that the setting mark is visible on the threaded rod above the sleeve.
8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:
1. Comply with concrete insert manufacturer's installation instructions.
2. Inserts shall be flush with slab bottom surface.
3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:
1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.
2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

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

3.4 FIELD QUALITY CONTROL

A. Site Tests:
   1. OWNER will employ testing agency to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
      a. Testing shall comply with ASTM E488.
      b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing, or at ENGINEER's option CONTRACTOR may arrange for testing paid by CONTRACTOR, for all adhesive anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, ENGINEER may require retesting of all anchors of the same diameter and type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
      c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
      d. Apply test loads with hydraulic ram.
      e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.

B. Manufacturer's Services:
   1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

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SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SCOPE

A. WORK INCLUDED: This section covers the work necessary to furnish and install, complete, the structural steel, and shall include all metal parts required for permanent connection of the structural steel.

B. GENERAL: Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

C. RELATED WORK SPECIFIED ELSEWHERE
1. Section 05500 - Miscellaneous Metal
2. Section 09900 - Painting

1.2 SUBMITTALS

A. Submittals during construction shall be made in accordance with the General Conditions of the Contract Documents.

B. Shop Drawings, complete with all information and sections.

1.3 QUALITY ASSURANCE

Reference Standards: Comply with the current provisions of the following, except as otherwise indicated:

A. AISC "Code of Standard Practice for Steel Buildings and Bridges"

B. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" and including the "Commentary of the AISC Specification"

C. AISC "Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts" approved by the Research Council on Structural Connections of the Engineering Foundation, August 14, 1985; endorsed by the American Institute of Steel Construction and the Industrial Fasteners Institute

D. AWS Structural Welding Code AWS D1.1-90 and "Standard Qualification Procedure"

E. ASTM A 36-61, Structural Steel (Rev. A)

F. ASTM A 53-83, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless

G. ASTM A 325-83, High Strength Bolts for Structural Steel Joints (Rev. C) (*A325M-83)

H. ASTM A 490-83, Heat-Treated Steel Structural bolts, 150 ksi Minimum Tensile Strength (Rev. A) (*A490M-82)

I. ASTM A 500-82, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes (Rev. A)

J. ASTM A 501-83, Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

K. AWS D1.1-90 (83), Structural Welding Code - Steel

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Load structural members in such a manner that they may be transported and unloaded without being excessively stressed, deformed, and otherwise damaged.

B. Material Storage:
1. Protect structural steel members and packaged materials from corrosion deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground.
2. Do not place materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. ROLLED PLATES, SHAPES, AND BARS: ASTM A 36 unless otherwise shown.

B. STRUCTURAL STEEL PIPE: ASTM A 501, or ASTM A 53, Type E or S, Grade B.

C. STRUCTURAL TUBING: ASTM A 501, or A 500, Grade B. All members shall be furnished full length without splices unless otherwise noted or approved.

D. BOLTS FOR CONNECTIONS: ASTM A 325 or A 490; use A 325 unless otherwise shown.

E. WELDED STUDS: Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by Nelson Stud Welding Company, Lorain, OH: Omark Industries, KSM Fastening Systems Division, Seattle, WA, or Portland, OR; or equal.

F. SHOP PAINT PRIMER: Structural steel shall be cleaned and coated with shop paint primer. Surface preparation and primer shall be as specified in Division 9 - Finishes. Shop prime coat shall be applied within 8 hours after surface preparation.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. MEASUREMENT: The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

B. SHOP DRAWINGS: Shop drawings shall conform to AISC recommendations and specifications and shall show all holes, etc., required for other work. Include complete details showing all members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

3.2 FABRICATION:

A. General
1. Fabricate items of structural steel in accordance with the Drawings, AISC Specifications, and as indicated on the final reviewed shop drawings.
2. Properly mark and matchmark materials for field assembly.
3. Where finishing is required, complete the assembly, including bolting and welding of units, before start of finishing operations.

B. Connections: Weld or bolt shop connections, as shown. Bolt field connections, except where welded connections or other connections are shown or specified. All connections unless shown otherwise shall develop

full strength of members joined and shall conform to AISC standard connections.

C. Welded Construction:
   1. Comply with AWS Current D1.1-90 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting welding work.
   2. Submit welder certifications for shop and field welders in triplicate, directly to the Engineer from a recognized testing laboratory, with copies to the Contractor and others as required.
   3. Unless otherwise shown, all butt welds are complete penetration.

D. Holes for Other Work: Provide holes as necessary or as indicated for securing other work to structural steel framing, and for the passage of other work through steel framing members. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work. No torch cut holes are permitted.

E. Shop Paint Primer: Apply shop paint primer in accordance with Division 9 - Finishes. Omit at welds, bolts, and where embedded in concrete. Remove all slag from welds before painting.

F. Inspection: Shop inspection may be required by the Owner at his own expense (except for weld inspection as mentioned herein). The Contractor shall give ample notice to the Engineer prior to the beginning of any fabrication work so that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop and inspectors shall be allowed free access to the necessary parts of the works. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but it is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under these Specifications.

3.3 ERECTION

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

B. Anchor Bolts:
   1. Furnish anchor bolts and other connectors required for securing structural steel to in-place work.
   2. Furnish templates and other devices for presetting bolts and other anchors to accurate locations.

C. Setting Bases and Bearing Plates:
   1. Clean concrete surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean the bottom surface of base and bearing plates.
   2. Set loose and attached baseplates and bearing plates for structural members on wedges, leveling nuts, or other adjustable devices.
   3. Tighten the anchor bolts after the supported members have been positioned and plumbed.
   4. Grouting of baseplates shall be as specified in Section 03600. Grout prior to placing loads on structure.

3.4 FIELD ASSEMBLY

A. Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

B. Level and plumb individual members of the structure within specified AISC tolerances. Contractor shall provide and install all temporary bracing required until structure is complete.

C. Establish required leveling and plumbing measurements on the mean operating temperature of the structure.

3.5 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified and shall select an industry acceptable method to remedy such as:
   1. Ream holes that must be enlarged to admit bolts and use oversized bolts.
   2. Plug weld misaligned holes and redrill holes to admit standard size bolts.
   3. Drill additional holes in the connection, conforming with AISC Standards for bolt spacing, and end and edge distances and add additional bolts.
   4. Reject the member containing the misfit, mis-sized, or misaligned holes and fabricate a new member to ensure proper fit.

B. Mis-sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

3.6 MISFITS AT ANCHOR BOLTS

Any misalignment between anchor bolts and bolt holes in steel members shall be resolved by submitting a request to the Engineer for review. The request shall show an industry acceptable method. Flame cutting to enlarge holes shall not be acceptable.

3.7 GAS CUTTING

Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing, except on secondary members which are not under stress and will be concealed in the finished structure and when approved by the Engineer. Finish gas-cut sections equal to a sheared appearance.

3.8 TOUCHUP PAINTING:

Immediately after section, clean field welds, bolted connections, and abraded areas of the shop paint primer. Apply touchup paint primer by brush or spray which is the same thickness and material as that used for the shop paint.

3.9 QUALITY CONTROL TESTING

A. The Engineer may engage inspectors to inspect bolted connections and welded connections and to perform tests and prepare test reports.

B. Weld Inspection:
   1. All butt welds shall be 100 percent tested in accordance with AWS D1.1-90, Part B, Radiographic Testing of Welds.
   2. The examination, report, and disposition of radiographs shall be in accordance with Section 6.12 of AWS D1.1-90. Payment of this work shall be included in the lump sum bid. All reports shall be submitted to the Engineer for review prior to completion of the work in this section.
   3. Welds that are required by the Engineer to be corrected shall be corrected or redone and retested as directed, at the Contractor's expense and to the satisfaction of the Engineer and/or approved independent testing lab.

C. Finish Painting:

   Finish painting of all exposed structural steel shall be as indicated on the Finish Schedule in the Drawings and as specified in Division 9.

END OF SECTION

SECTION 05130
STRUCTURAL ALUMINUM FRAMING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install structural aluminum framing.
   2. The Work also includes:
      Providing openings in and attachments to structural aluminum framing to accommodate the Work under this and other Sections, and providing for structural aluminum framing items such as anchorage devices, studs, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before structural aluminum framing Work.

C. Related Sections:
   1. Section 03600, Grout.
   2. Section 05051, Anchor Systems.
   3. Section 09900, Painting.

1.2 REFERENCES

Standards referenced in this Section are:
   1. AA ADM-1, Aluminum Design Manual – Specifications for Aluminum Structures.
   2. AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts, approved by RCSC.
   3. ASTM A325, Specification for Structural Bolts, Steel, Heat-Treated, 120/105 KSI Minimum Tensile Strength.
   4. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   5. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   6. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

7. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
8. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
9. ASTM B429/B429M, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
10. ASTM F436, Standard Specification for Hardened Steel Washers.
11. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
12. ASTM F594, Specification for Stainless Steel Nuts.
13. AWS D1.2/D1.2M, Structural Welding Code - Aluminum.
14. NAAMM AMP 500, Metal Finishes Manual for Architectural and Metal Products.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.2/D1.2M.

B. When requested by ENGINEER, provide certification that all welders employed on or to be employed on the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Complete details and schedules for fabrication and shop assembly of members and details, schedules, procedures, and diagrams showing proposed sequence of erection. Shop Drawings shall not be reproductions of Contract Drawings.
      b. Include complete information for fabrication of the structure's components, including location, type, and size of bolts, details of blocks, copes and cuts, connections, camber, holes, member sizes and lengths, and other pertinent data. Clearly indicate welds using standard AWS notations and symbols, and clearly show or indicate size, length, and type of each weld.
      c. Provide setting drawings, templates, and directions for installing anchorage devices.
   2. Product Data:
      Copies of manufacturer's specifications and installation instructions for products listed below:
      Welding electrodes and rods.

B. Informational Submittals: Submit the following:

1. Certificates.
   Welders' certifications, when requested by ENGINEER.
2. Test Reports.
   Laboratory test reports and other data required to show compliance with the Contract Documents for the following:
   a. Mill test report documenting chemical and physical properties of each type of aluminum framing material.
   b. Mill test report documenting chemical and physical properties of stainless steel connection bolts, nuts, and washers.
3. Field Quality Control Submittals:
   Submit results of testing and inspection performed at the Site by testing agency employed by CONTRACTOR.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the Site at such intervals to ensure uninterrupted progress of the Work.

B. Storage:
   Do not store materials in a manner that could cause distortion or damage to the members. Repair or replace damaged materials as directed by ENGINEER.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Aluminum Types:
   1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B221, Alloy 6061-T6.
   2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
   3. Aluminum Bars and Rods: ASTM B211, Alloy 6061-T6.
   4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

B. Anchorages, Fasteners, and Connectors:
   1. Anchorage Devices: Refer to Section 05 05 33 Anchor Systems.
   2. Threaded Fasteners: Stainless steel bolts, ASTM F593, AISI Type 303, and stainless steel nuts and washers, ASTM F594, AISI Type 303.
   3. Bolts used in slip-critical connections shall comply with ASTM A325; nuts shall comply with ASTM A563 Grade DH; and washers shall comply with ASTM F436. Bolts, nuts, and washers shall be zinc-coated by the hot-dip process in accordance with ASTM A325.

C. Electrodes for Welding: ER 5356 complying with AWS D1.2/D1.2M.

D. Finish: Provide mill finish as specified in NAAMM AMP 500.

2.2 FABRICATION

A. Shop Fabrication and Assembly:
   1. Fabricate and assemble structural assemblies in the shop to greatest extent possible. Fabricate items of structural aluminum in accordance with AA ADM-1, the Contract Documents, and as shown on approved Shop Drawings. Provide camber in structural members as shown.
   2. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence that will expedite erection and minimize handling of materials for storage and minimize handling at the Site.
   3. Where finishing is required, complete the assembly, including welding of units, before commencing finishing operations. Provide finish surfaces of members exposed-to-view in the completed Work that are free of markings, burrs, and other defects.
   4. Details shown on the Drawings are typical; similar details apply to similar conditions, unless otherwise shown or specified.

B. Connections:
   1. Shop Connections:
      a. Unless otherwise shown or indicated, shop connections may be welded or stainless steel bolted. Unless shown otherwise, welds shall be 1/4-inch minimum.
      b. Where reaction values of a beam are not shown or indicated, connections shall be detailed to support the total uniform load capacity tabulated in AA ADM-1 tables for allowable loads on beams for the given shape, span, and aluminum specified for beam in question.
      c. Shop-welded connections shall be detailed to eliminate or minimize eccentricity in the connection.
      d. End connection angles fastened to webs of beams and thickness of angles, size and extent of fasteners or shop welds, shall comply with design standards in AA ADM-1. Connections shall be two-sided unless otherwise shown or indicated.
   2. Fabrication Considerations Regarding Field Connections:
      a. Unless otherwise specified below or indicated, make field connections using stainless steel bolts.
      b. Field welding is not allowed.
   3. Bolted Construction:
      a. Stainless steel design shear values shall be based on bolts with bearing type connections with threads in the shear plane.
      b. Bolted connections shown or indicated as “SC” shall comply with slip-critical connection requirements in AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.
         1) Faying surfaces shall have a Class B surface condition.

2) Slip-critical bolts shall be fully pre-tensioned as indicated in AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 Bolts.

c. Minimum bolt diameter shall be 3/4-inch, unless otherwise shown or indicated.

4. Welded Construction: Comply with AWS D1.2/D1.2M for procedures, appearance, and quality of welds, and methods used in correcting defective welding Work.

C. Bracing:
1. Bracing for which stress is not shown or indicated shall have minimum two-bolt connection, or shop-welded connection of equivalent strength.
2. Vertical bracing and knee braces connecting to columns shall be on the centerline of columns, unless otherwise shown or indicated.
3. Knee braces shall be at 45-degree angle, unless otherwise shown or indicated.
4. Connection plates shall be minimum 3/8-inch thick, unless otherwise shown.

D. Columns: Fabrication tolerances shall be as required by AA ADM-1 and AWS D1.2/D1.2M for welded members.

E. Holes and Appurtenances for Other Work:
1. Provide holes required for securing other work to structural aluminum framing, and for passage of other work through framing members, as shown on the Shop Drawings and the Contract Documents. If large block-outs are required and approved, reinforce the webs to develop specified shear strength. Provide threaded nuts welded to framing, and other specialty items as shown to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. Do not frame cut holes or enlarge holes by burning. Drill holes in bearing plates.

PART 3 – EXECUTION

3.1 INSPECTION

Examine areas and conditions under which structural aluminum Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 ERECTION

A. Comply with AA ADM-1 and the Contract Documents.

B. Anchorage Devices:
   1. Provide anchorage devices, including anchor bolts, and other connectors required for securing structural aluminum to foundations and other in-place Work.
   2. Provide templates and other devices necessary for pre-setting anchorage devices to accurate locations.
   3. Refer to Section 05051, Anchor Systems, for anchorage requirements.

C. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.
   1. Set loose and attached base plates and bearing plates for structural members on stainless steel wedges or other adjusting devices.
   2. Tighten anchorage devices after positioning and plumbing supported members. Do not remove wedges or shims, but if protruding, cut off flush with edge of the base or bearing plate prior to packing with grout.
   3. Place non-shrink grout between bearing surfaces and bases or plates in accordance with Section 03600, Grouting. Finish exposed surfaces, protect installed materials, and cure in compliance with grout manufacturer's instructions.
   4. Leveling plates and wood wedges are not allowed.

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

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

F. Gas Cutting: Do not use gas-cutting torches at the Site for correcting structural framing fabrication errors. Field-cutting will be allowed only on secondary members that are not under stress, as approved by ENGINEER. Finish gas-cut sections equal to sheared appearance when allowed.

G. Protection of Aluminum from Dissimilar Materials:
   Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09900, Painting.

3.3 FIELD QUALITY CONTROL

A. Engage an independent testing and inspection agency to inspect stainless steel bolted connections and welded connections as follows:
   1. Visually inspect all welds. Test wells that appear to be visually deficient using non-destructive methods by qualified testing laboratory. CONTRACTOR shall correct improper workmanship by removing and replacing, or repairing, as instructed by ENGINEER, welds that are defective. Pay for all corrections and subsequent retesting to confirm integrity of welds.
   2. Visually inspect all bolted connections.
      a. Visually inspect connections to verify that plies of connected elements are in snug contact.
      b. For connections that are slip-critical or subject to axial tension, inspector shall verify proper pre-tensioning in accordance with Paragraph 2.2.B.3.b of this Section.
      c. Where bolts or connections are defective, correct improper workmanship and materials by removing defective bolts and connections and replacing or repairing as directed by ENGINEER. Pay for corrections and subsequent tests required to confirm integrity of connection.
   3. Independent testing and inspection agency shall prepare a report on each structure. Report shall summarize observations made by inspector and be submitted to ENGINEER.

B. Correct defecctive structural aluminum Work. Perform additional tests, at CONTRACTOR'S expense, necessary to confirm non-compliance of the original Work and to demonstrate compliance of corrected Work.

END OF SECTION

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SECTION 05500

MISCELLANEOUS METALS

PART 1 - GENERAL

1.1 SCOPE

The Contractor shall furnish all labor, materials, equipment and incidentals required and install all miscellaneous metals as shown on the Drawings and specified herein. The miscellaneous metal items include, but are not limited to, the following:

A. Anchors or anchor bolts unless otherwise specified in other Sections of these Specifications.

B. Ladders

C. Grating

D. Manhole frames and covers

E. Grates and frames

F. Manhole steps

G. Miscellaneous aluminum and steel items

1.2 SUBMITTALS

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

A. Manufacturer's data on all materials listed in Part 2 of this Section.

B. Detail drawings showing sizes of members, method of assembly, anchorage, and connection other members shall be submitted to the Engineer for review before fabrication.

1.3 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or specified herein.

A. ASTM A36 – Standard Specification for Carbon Structural Steel

B. ASTM A48 – Standard Specification for Grey Iron Castings

C. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless

D. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

E. ASTM A153 – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

F. ASTM A167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip

G. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes

H. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

I. ASTM B241 – Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

J. AWS Specifications for Arc Welding

1.4 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections.

B. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.5 FIELD MEASUREMENTS

Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this section, before during and after installation and to protect the work and materials of all other trades.

B. Delivery and storage: Deliver materials to the jobsite, and store in a safe dry place with all labels intact and legible at the time of installation.

C. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.7 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel:
1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A500, Grade B.
4. Angles, Plates, Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Aluminum:
1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

C. Stainless Steel:
1. Plates and Sheets: ASTM A240/A240M, Type 304L or Type 316 stainless steel.
2. Submerged or Intermittently Submerged: Type 316 stainless steel.
3. Non-submerged: Type 304L stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 304L or Type 316 Stainless Steel.

E. Zinc-coated Hardware: ASTM A153/A153M.

2.2 ANCHORS, BOLTS AND FASTENING DEVICES

A. Anchors, bolts and fastening devices shall be furnished as necessary for installation of the work of this Section and shall be designed in accordance with Section 05051.

B. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum, iron, steel, and stainless steel shall be attached to concrete by means of stainless steel machine bolts unless otherwise specifically noted.

2.3 ALUMINUM ITEMS

A. Miscellaneous aluminum shapes and plates shall be fabricated as shown. Angle frames for hatches, beams, grates, etc., shall be furnished complete with welded strap anchors attached. Furnish all miscellaneous aluminum shown but not otherwise detailed. Structural shapes and extruded items shall conform to the detail dimensions on the Drawings within the tolerances published by the Aluminum Association.

B. Aluminum Ladders
   1. Aluminum ladders shall be high strength 6061-T6 aluminum alloy and shall be fabricated to the required height as shown on the Drawings. Rung diameter shall be 1-inch minimum with 12-inches spacing between rungs and 18-inches between ladder rails. Ladder rungs shall have slip resistant surface. Ladders shall have a minimum of 3 pairs of brackets for wall attachment.
   2. Ladders shall meet the requirements of OSHA and ANSI standards.
   3. Ladders shall be furnished with safety posts to allow for a hand-hold when entering or exiting vaults and other structures.
      a. Safety posts shall be 48-inches long when fully extended. The safety post shall have a telescoping tubular section that locks automatically when fully extended and a release lever to allow it to be returned to its lowered position.
      b. Safety post shall be manufactured of high strength square tubing.
      c. All hardware for mounting safety post to ladder shall be type 316 stainless steel and shall be furnished by the post manufacturer.
      d. Ladder safety post shall be preassembled by the manufacturer and shall be LadderUP Safety Post Model LU-4 as manufactured by the Bilco Company or approved equal.

C. Aluminum Grating
   1. Aluminum grating shall be 1 ¼-inch minimum thickness and shall be designed to support a loading of 150 pounds per square foot.
   2. All openings 2-inches or greater in diameter shall be banded with a bar of the same depth and thickness as the main bearing bars of the grating or furnished with continuous cross bridges. Each cut bar shall be welded to the band if banding is utilized. The ends of all grating sections shall be likewise banded.
   3. Clamps and bolts used for attaching grating to support members shall be stainless steel. All grating shall be clamped unless noted otherwise. Clamps shall be as recommended by the grating manufacturer.

2.4 MANHOLE FRAMES AND COVERS AND GRATES AND FRAMES

A. Castings for manhole frames and covers and grates and frames shall conform to ASTM A48 for Class 30 gray iron castings. Castings shall be made accurately to the dimensions as shown on the Drawings. Castings for manhole frames and covers and frames and grates shall be 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. 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 and grates and frames shall be fitted before leaving the foundry.

C. Manhole Frames and Covers
   1. Manhole frames and covers shall be as shown on the Drawings and shall be as manufactured by East Jordan Iron Works, Neenah Foundary, or approved equal.
   2. Manhole covers on sanitary sewer systems shall be solid type unless indicated otherwise on the Drawings.
   3. Manhole covers on storm drainage systems shall be vented, unless indicated otherwise on the Drawings.
   4. Watertight manhole frames and covers, where indicated on the Drawings, shall be bolt down type and shall be equipped with four 5/8-inch stainless steel bolts and o-ring gasket.
   5. Manhole covers installed on air release and vacuum valve vaults shall be vented.

D. Grates and Frames: Grates and frames shall be as shown on the Drawings and shall be as manufactured by East Jordan Iron Works, Neenah Foundry or approved equal.

2.5 STEEL ITEMS

A. Manhole Steps
   1. Manhole steps shall be made of a steel rod encapsulated in copolymer polypropylene and shall be model PS-1 PF as manufactured by M. A. Industries, Inc. or approved equal.
   2. Manhole steps shall be installed at intervals as shown on the Drawings. Steps shall be as shown on the Drawings and shall have rod and pull ratings meeting OSHA standards.

B. Miscellaneous steel shall be fabricated and installed in accordance with the Drawings and shall include: beams, angles, support brackets, splice plates, anchor bolts, lintels and any other miscellaneous steel called for on the Drawings and not otherwise specified.

C. Stainless Steel. Unless otherwise designated or approved, use stainless steel alloy types as follows which conform to ASTM A167 and ASTM A276.
   1. Stainless steel plates and bars shall be Type 316 or Type 317 unless otherwise noted.
   2. Stainless steel anchor bolts shall be Type 316.
   3. Stainless steel bolts, nuts and washers shall be Type 316.

D. Bollards: Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance with Section 09900, Painting. Unless otherwise shown or specified, finish-paint bollard "Safety Yellow."

E. Shelf Angles:
   1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
      a. Provide galvanized shelf angles on outdoor construction.
   2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

PART 3 - EXECUTION

3.1 FABRICATION

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the Standard Code for Arc and Gas Welding in Building Construction of the AWS and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. Welding of aluminum work shall be on the unexposed side as much as possible in order to prevent pitting or discoloration.

F. All aluminum finish exposed surfaces, except as specified below, shall have manufacturer's standard mill finish. A coating of methacrylate lacquer shall be applied to all aluminum before shipment from the factory.

G. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All finished surfaces shown on the Drawings and/or specified shall be machined to a true plane surface and shall be true and seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified or shown shall not be reduced in obtaining finished surface. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from the dimensions shown. The Contractor shall provide facilities for weighing castings in the presence of the Engineer showing true weights certified by the supplier.

H. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter before shipment and shall be given one shop coat of primer compatible with finish coats specified in Painting Section after fabrication but before shipping. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces, Abrasions in the field shall be touched up with primer immediately after erection.

I. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz. per sq. ft. of surface. The galvanized coating shall be chromate treated.

3.2 INSTALLATION

A. Install all items furnished except items to be imbedded in concrete which shall be installed under Division 3. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown and in accordance with manufacturer’s instructions and approved shop drawings. All dimensions shall be verified at the site before fabrication is started.

B. All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling

mastic applied in accordance with the manufacturer's instructions prior to installation.

++ END OF SECTION ++

SECTION 05524

COMPONENT ALUMINUM HANDRAIL

PART 1 - GENERAL

1.1 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.

1.2 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 International Building Code with local code amendments.

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:
      a. 50 pounds per linear foot applied horizontally to the top rail and a vertical load of 100 pounds per foot applied simultaneously.
      b. 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.

1.3 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.

D. Submit signed and sealed drawing showing the extent of railing, proposed railing layout, type of railing, and railing anchorage detail for the project.

1.4 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.

1.5 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

2.1 ACCEPTABLE MANUFACTURERS

Component aluminum handrail system shall be manufactured by Thompson Fabricating Company of Birmingham, Alabama, Alumagard of Denver, Colorado, or Hollaender Manufacturing of Cincinnati, Ohio.

2.2 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 METAL, 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

3.1 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.

3.2 CLEANING

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+++

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DIVISION 7

THERMAL AND MOISTURE PROTECTION

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SECTION 07190
VAPOR BARRIER

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish all materials, labor, equipment, and incidentals required to perform all vapor barrier work and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

B. Related Work Specified Elsewhere:
Section 03300, CAST-IN-PLACE CONCRETE.

1.2 SUBMITTALS

Submit to the Engineer as provided in the General Conditions for shop drawings, detailed information on materials proposed and installation methods.

PART 2 – PRODUCTS

2.1 MOISTURE BARRIER (UNDER CONCRETE SLABS)

Where so indicated on the Drawings, provide a moisture barrier consisting of pre-molded, membrane meeting the standard of ASTM E-96, Method B, 1980 and ASTM D781, 1968, ASTM D1228, 1964.

2.2 OTHER MATERIALS

Provide other materials, not specifically described but, required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 – EXECUTION

3.1 SURFACE PREPARATION

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install vapor barrier under concrete slabs-on-grade, sealing all lap joints, around all protrusions, and at slab edges.

B. Vapor barrier to extend continually from the top of footing or to be sealed to the foundation wall, or to extend to the outside edge of a monolithic slab or patio.

C. Vapor barrier to extend continually from the top of footing or to be sealed to the foundation wall, or to extend to the outside edge of a monolithic slab or patio.

D. All punctures in vapor barrier to be repaired with same material, lapped at least 12 inches, taped and sealed.

E. Field fabricate a sealing boot around all utility entries and other penetrations and seal boot airtight to vapor barrier and conduit.

++ END OF SECTION ++

SECTION 07900

CAULKING AND SEALANTS

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish all materials, labor, equipment, and incidentals required to perform all caulking, and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

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.

1.2 APPLICATION SCHEDULE

A. Caulk all exterior wall joints between frames in openings and adjacent materials, between masonry and cast in place concrete, expansion and control joints and all other joints shown on the Drawings or required for the completion of the work.

B. Caulk all interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete and control joints, exterior window and door frames and all other joints shown on the drawings or required for the completion of the work.

C. Joints of similar nature to those indicated shall be sealed with same sealer, whether indicated on Drawings to be sealed or not.

1.3 SUBMITTALS

A. Submit to the Engineer as provided in the General Conditions for shop drawings, detailed information on materials proposed and installation methods.

B. Product Data: Manufacturer's technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.

C. Samples for Color Selection: Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available, for each product exposed to view.

D. Samples for Color Verification: Samples of each type and color of joint sealer required. Install joint sealer samples in 1/2 inch wide joints formed between two 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealers in the Work.

1.4 QUALITY ASSURANCE

A. Applicable standards: Standards of the following, as referenced herein:

ASTM C 920-98 Standard Specification for Elastomeric Joint Sealants, 1998.

B. Preinstallation Meeting: The contractor shall arrange a meeting with installer, sealer manufacturers' representatives, and other trades whose work affects installation of sealers at project site to review procedures and time schedule proposed for installation of sealers which is coordinated with other related work.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original unopened containers or bundles with labels showing manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of sealers under the following conditions:
   1. When ambient and substrate temperature conditions are outside the limits permitted by sealer manufacturer or below 40 degrees F (4.4 degrees C).
   2. When substrates are wet due to rain, frost, condensation, or other causes.

B. Joint Dimension Conditions: Do not proceed with installation of sealers when joint dimensions are less than recommended by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.1 CAULKING

A. Caulking Compound: One component, synthetic rubber base sealant, soft curing, nonstaining, conforming to F.S. TT S 00230 and Thiokol's Building Trade Performance Specifications for Type 1 Class B sealants. Caulking for use within chemical containment areas shall be one component, elastomeric, ultra chemical resistant sealant suitable for exposure to 15% sodium hypochlorite. Colors shall be selected by the Engineer.

B. Primer: As recommended by caulking compound manufacturer.

C. Back up Material: Closed cell foam polyethylene, or similar non bituminous material as recommended by manufacturer of caulking compound and completely compatible with selected compound.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION AND INSTALLATION

A. Remove dirt, grease, mortar droppings and other foreign matter from substrate.

B. Require installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.2 CAULKING

A. Surface Preparation: Clean metal surfaces free of grease, oil, wax lacquer, and other foreign residue by wiping with a clean cloth moistened with a suitable solvent. Scape or brush masonry surfaces clean. Apply appropriate primer to contact surfaces.

B. Joint Preparation: Joints to be caulked having a depth in excess of 3/8 inch shall be packed with back up material. Round back up material shall be sized to require 20 percent to 50 percent compression upon insertion. In joints not of sufficient depth to allow packing, install polyethylene bond

breaking tape at back of joint. Avoid lengthwise stretching of back up material. Cut all corners, avoid wrapping around corners.

C. Application: Apply compound with pressure flow gun with nozzle of proper size and shape to suit width of joint, promptly after mixing and with sufficient pressure to fill joint. Apply as a continuous operation horizontally in one direction, and vertically from bottom to top, except joints having excessive widths where compound might sag, the joints shall be built up with successive beads. Finish joints smooth and slightly coved.

3.3 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

END OF SECTION

DIVISION 8

DOORS AND WINDOWS

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SECTION 08110
STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all steel doors and frames. 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. Section includes:

1. Fire rated steel doors and frames.
2. Insulated doors.

D. Related work specified elsewhere:

1. Section 08710, Finish Hardware.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical data substantiating that products comply with requirements.

B. Shop Drawings: Submit shop drawings for fabrication and installation of specified items, coordinated with opening schedule shown on the Drawings; include the following information:

1. Details of construction, joints, and connections.
2. Details of each frame type, including anchorage.
3. Elevations of each opening type.
4. Conditions at openings.
5. Location and installation requirements of door hardware and reinforcements.
6. Schedule of openings coordinated with numbering system used in contract documents.

C. Hardware templates shall be furnished to the door manufacturer by the Contractor for correct hardware alignment and reinforcing.

D. Samples: Submit as follows for composite metal doors and frames:

1. Door: 1'-0" by l'-0" corner section showing door construction.

2. Welded frame: 1'-0" by 1'-0" head and jamb corner section showing welded corner construction.

3. Anchors: One of each type.

E. Product data: Indicate that hollow metal work complies with specified requirements, including performance criteria.

1.4 DELIVERY, STORAGE AND HANDLING

Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact. Doors and panels shall be individually wrapped in corrugated cardboard with wood strips on vertical edges and banded with metal straps. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations. Handle in accordance with manufacturer's instructions.

1.5. QUALITY CRITERIA

A. Applicable standards: Standards of the following, as referenced herein:

1. American National Standards Institute, Inc. (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Steel Door Institute (SDI).
4. National Fire Protection Association (NFPA), National Fire codes.
5. Underwriters Laboratories, Inc. (UL)

B. Furnish fire rated components bearing factory applied labels of Underwriters Laboratories, Inc. (UL) giving component rating.

C. Allowable erection tolerances:

1. Variation from specified clearances: 1/32".
2. Variation in face alignment, pairs of doors: 1/16".
3. Variation in face alignment between door and frame: 1/8" maximum.

D. Performance criteria:

1. Physical endurance: Comply with performance level for specified grade classification in accord with SDI-100-85 and ANSI A151.1-1980 for doors and

hardware reinforcing, ANSI/SDI-119 1983 for frames and anchors.

2. Finish: Comply with standard performance criteria of ANSI A224.1-1980 for primed steel surfaces.

3. Thermal performance: U=0.24 or better, apparent thermal performance in accord with SDI 113-79.

4. Air infiltration:
Maximum 1.25 cfm/1.5. at 1.567 psi (24 mph) in accord with SDI-116-79.

E. Field Verification: Field verify existing frame opening dimensions. Before ordering frames, notify Engineer of discrepancies between field dimensions and frame sizes indicated on drawings.

1.6 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 METAL DOORS

A. Type and design:

Provide full-flush design, in dimensions and types shown on the Door Schedule in the Drawings, 16 gauge properly reinforced for the finish hardware.

B. Finish: Hot-dipped galvanized steel with zinc coating conforming to ASTM A525. Prime paint at the factory.

C. Manufacturers: Products of the following manufacturers, or equal, meeting these specifications, may be used on this project:

1. Amweld
2. The Steelcraft Mfg. Co.
3. The Ceco Corporation
4. Republic Steel Corporation
5. Or equal.

D. Door Classification:

Label fire-rated composite metal doors: (Class B, 90 minute doors) with mineral fiberboard core, 14 ga., 1-3/4" thickness.

E. Door Construction:

1. Edge bevel: Vertical edges beveled 1/8" in 2".
2. All door edges to be continuously fully welded and ground smooth; not voids.
3. Fabricate all doors with flush top and bottom closing channel, without exposed fasteners. Reinforce tops and bottoms of doors with inverted, flush-mounted, minimum 20-gauge, horizontal steel channels fastened to internal reinforcement channel and with 20-gauge closing plate spot-welded to closure channel. Close top and bottom edges to provide weather seal, as integral part of door construction or by addition of inverted steel channels and plates.

2.2 METAL FRAMES

A. Construction: 14 gauge interior, 14 gauge exterior welded cold-rolled steel construction, with joints full welded, dressed and ground smooth. Provided welded frames with temporary spreaders during shipping and erection.

B. Finish: Hot-dipped galvanized steel with zinc coating conforming to ASTM A525. Prime paint at the factory with Rust-inhibitive enamel or paint either air drying or baking, suitable as a base for specified finish paints.

C. Frame anchors:

1. Wall anchors for frame attachment to masonry walls: Manufacturer's standard adjustable type for attachment to masonry. Fabrication of not less than 18 gauge galvanized steel. Provide one anchor per jamb for each 2'-0" of height or fraction thereof.

2. Floor anchors: Clip type to receive two fasteners per jamb, welded to bottom of jambs and mullions.

3. In-place masonry or concrete: 3/8" countersunk, flat head, stove bolts fabricated from A151, Type 316 stainless steel of expansion shields, spaced 6" maximum from top and bottom of frame 2'-0" o.c. maximum.

D. Applied stops: Formed, 20 ga. steel with mitered corners. Attach using countersunk oval head machine screws at 1'-0" o.c., maximum.

E. Preparation for hardware:

1. Reinforcement: Reinforce components for hardware installation in accord with SDI-100-85.

2. Punch single leaf frame to receive three silencers: double leaf frames to receive two silencers per leaf, at head.

3. Factory prepared hardware locations shall be in accordance with "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames", as adopted by the Steel Door Institute.

F. Wide Openings: Reinforce frame wider than 48" with roll formed steel channels fitted tightly into frame head, or provide frames of minimum 14 gauge steel.

G. Inserts, Bolts and Fasteners: Sheet metal hot-dip galvanized complying with ASTM A 153/A 153 M, Class C or D as applicable.

H. Mullions and Transom Bars: Provide closed mullions and transom bars where shown. Fasten mullions and transom bars at crossings and to jambs by butt-welding. Reinforce joints between frame members with concealed clip angles or sleeves of same metal and thickness as frame.

I. Plaster Guards: Provide manufacturer's standard plaster guards or dust cover boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All frames and fittings shall be installed and adjusted in strict accordance with the recommendations of the manufacturer and the approved shop drawings.

B. After erection of doors and frames, precautionary methods shall be employed to adequately protect exposed surfaces of installed items from damage due to installation of other work from lime, acid, cement, or other harmful compounds.

3.2 DOOR INSTALLATION

A. Install hollow metal doors in frames, using hardware specified in Finish Hardware section.

B. Edge clearances at doors:

1. Between door and frame, at head and jambs: 1/8".
2. At meeting edges of pairs of doors: 1/8".
3. At sills without thresholds: 3/8" maximum above finished floor.
4. At sills with thresholds: 3/8" maximum above top of threshold.

C. Fire-rated doors: Install in accord with requirements of NFPA 80.

3.3 SETTING FRAMES

A. Install hollow metal frames in accord with SDI-105 "Recommended Erection Instructions for Steel Frames", approved shop drawings and product data.

B. Welded frames:

1. Set welded frames in position prior to beginning partition work. Brace frames until permanent anchors are set.

2. Set anchors for frames as work progresses. Install anchors at hinge and strike levels.

3. Remove temporary braces and spreaders after wall construction is complete.

4. Install welded frames in prepared openings in concrete, masonry and clay tile walls using countersunk bolts and expansion shields.

C. Fire-rated frames: Install in accord with requirements of NFPA 80.

3.4 ADJUST AND CLEAN

A. Prime coat touch-up: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touch-up coat of compatible air-drying primer.

B. Final Adjustments: Check and readjust operating door hardware items, leaving work of this section undamaged and in complete and proper condition.

++ END OF SECTION ++

SECTION 08331

OVERHEAD ROLLING DOORS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish all labor, materials, equipment, and incidentals required and install the overhead doors as shown on the drawings and specified herein.

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. Related Sections:
1. Section 05500: Miscellaneous Metals.
2. Section 09900: Painting.
3. Section 08710: Finish Hardware.
4. Section 16150: Electric Motors.

1.2 SUBMITTALS

A. Submit to the Engineer for approval, as provided in the General Conditions, shop drawings showing plans, rough-in diagrams, dimensions, sections, finishes and elevations; fabricating, arranging, and fastening details; materials of fabrication, including hardware and reinforcement; methods of fabrication; and manufacturer's printed installation and maintenance instructions.

B. Color Samples: Manufacturers current color sample(s) for factory finish coating.

1.3 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, Inc. (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Steel Door Institute (SDI).

4. National Fire Protection Association (NFPA), National Fire codes.
5. Underwriters Laboratories, Inc. (UL)

B. Furnish fire rated components bearing factory applied labels of Underwriters Laboratories, Inc. (UL) giving component rating.

C. Allowable erection tolerances:
1. Variation from specified clearances: 1/32".
2. Variation in face alignment, pairs of doors: 1/16".
3. Variation in face alignment between door and frame: 1/8" maximum.

D. Performance criteria:
1. Physical endurance: Comply with performance level for specified grade classification in accordance with SDI-100-85 and ANSI A151.1-1980 for doors and hardware reinforcing, ANSI/SDI-119 1983 for frames and anchors.
2. Finish: Comply with standard performance criteria of ANSI A224.1-1980 for primed steel surfaces.
3. Thermal performance: U=0.48 (R=2.1) or better, apparent thermal performance in accord with SDI 113-79.
4. Air infiltration: Maximum 1.25 cfm/1.5 at 1.567 psi (24 mph) in accord with SDI-116-79.

E. Field Verification: Field verify frame opening dimensions. Before ordering frames, notify Engineer of discrepancies between field dimensions and frame sizes indicated on Drawings.

1.4 WARRANTY

Provide a warranty against defective equipmen and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Overhead Rolling Doors shall be face of wall mounted, of the size indicated, with chain and chain wheel manual operation:
1. Curtain shall be No. 6 Slat, 12 gage aluminum designed to resist a wind pressure of 20 pounds per square foot; deflection shall not exceed 1/240 of the opening width. Curtain shall roll up on a bracket-supported drum, and shall be balanced with a helical spring.
2. Endlocks shall be of the wind lock design.
3. Bottom rail angles to be aluminum of equal weight, and shall be securely fastened to each side of the bottom of the curtain.

B. Hardware shall be heavy duty type. Door frame to be A151, type 316 stainless steel and guides shall be not thinner than 3/16 inch, and shall form a channel picket of a depth which will retain the curtain in place when the curtain is subjected to the wind pressure stipulated above.

C. Weather stripping shall consist of a rubber loop type astragal affixed to the bottom rail and extending into each channel picket guide, and a rubber strip affixed to the exterior of each guide, thus closing the space between the guide and the curtain.

D. Hood shall be of .04" thick aluminum with air baffle formed to fit the contour of end brackets, and shall be reinforced with either steel rods or rolled beads at the top and bottom edges. A rubber neoprene or vinyl water seal at the hood shall be provided to prevent airflow around the coil on all exterior doors.

E. Bottom Draft Seal: Provide flexible seal assembly across full width of door on the bottom panel edge. Bottom panel shall be designed to compensate for sloped floors up to an edge-to-edge difference of 2 inches.

F. Door to be chain operated, flat slat rolling overhead door, model No. FCM-MOTOR as manufactured by the Cookson Company or approved equal.

2.2 ELECTRIC OPERATOR

A. The electric power drive units shall be suitable for use in hazardous areas classified Class 1, Division 1, Group D. The electric power drive shall consist of a high starting torque enclosed gear motor equipped with an integral brake of adequate size acting on the motor shaft, and a worm gear reducer. This unit shall drive the hoist through an adjustable friction clutch which shall be arranged such that in the event of power failure the chain operated clutch will disengage the power drive unit and permit manual operation of the door by means of a chain which shall directly operate the geared hoist. Emergency operation of the door by hand chain, operating through the motor gearing, will not be permitted.
   1. Provide hand-operated disconnect or a mechanism for automatically engaging a sprocket and chain operator and releasing brake for emergency manual operation.
   2. Mount disconnect and operator so they are accessible from floor level.
   3. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
   4. Design operator so that motor may be removed without disturbing limit-switch adjustment or affecting emergency auxiliary operator.

B. Electrical controls shall be suitable for use in hazardous areas classified Class 1, Division 1, Group D. The controls shall be 3-button momentary

contact push button stations with open, close and stop buttons. One push button station shall be furnished for the interior most opening. Two Nema Type 1 push button stations shall be provided for the entrance opening. Constant pressure on the closed button shall be required to lower the door panels. Cam actuated limit switches located on the door guide shall stop the panels at the fully opened and fully closed position. Safety edge bottom bar shall not act as a limit switch.

2.3 FINISH

Finish: Aluminum curtain slats, aluminum hood and all other miscellaneous aluminum parts shall be 5052-H32 alloy conforming to ASTM 8 (209) 1983, and shall have a factory finish compatible for field finish painting.

2.4 AUTOMATIC REVERSING CONTROL

A. Furnish curtain with automatic safety switch of type indicated, and complying with UL 325. Extend switch full width of curtain bottom, and locate within neoprene or rubber astragal mounted to bottom curtain rail.

B. Contact with switch before fully closing will immediately stop downward travel of overhead coiling curtains and reverse direction to fully opened position.

C. Connect to control circuit through retracting safety cord and reel, or through self-coiling cable.

D. Where indicated, provide electrically actuated automatic bottom bar.

PART 3 - EXECUTION

3.1 INSTALLATION

Overhead Rolling Door shall be installed where indicated, and in accordance with the manufacturer's printed installation instructions. Horizontal lines shall be level, and vertical lines shall be plumb. Anchors for guides, brackets, and other fasteners shall be located where indicated.

3.2 ADJUSTING AND CLEANING

Adjusting and Cleaning shall consist of ensuring smooth operation, lubricating and testing the overhead door, and of preparing the overhead door for field painting. Overhead doors shall operate smoothly, quietly, and without squeaking and binding.

+++ END OF SECTION +++

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SECTION 08513
ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all aluminum windows Work.
   2. Extent of the aluminum windows is shown and specified.
   3. Types of products required include the following:
      a. Custom High Performance Insulated Thermal-Barrier Aluminum Windows:
         1) Project-in thermal barrier operable assemblies within fixed aluminum windows.
         2) Fixed thermal barrier aluminum windows.
         3) Tubular muntins and intermediates providing true divided lites, mullions and all custom accessories and fasteners.
         4) Gaskets, pressure plates and snap covers in conjunction with each of the above components.
         5) Intermediate mullions and all accessories and fasteners.
         6) Hardware, custom panning and miscellaneous materials.
         7) Anchors, inserts, support brackets, expansion devices, fasteners, flashings, weeps, and similar elements in conjunction with each of the above components.
      b. Complete selection of custom and premium custom-blended full-strength polyvinylidene fluoride finishes and colors with extended life topcoat.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the aluminum windows Work.
   2. Notify other contractors in advance of the installation of the aluminum windows to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the aluminum windows Work.

C. Related Sections:
   1. Section 07900, Caulking and Sealants.
   2. Section 08800, Glass and Glazing.

1.2 REFERENCES

Standards referenced in this Section are listed below:
   A. American Architectural Manufacturer's Association, (AAMA).

1. AAMA 101, Voluntary Specifications for Aluminum Prime Windows and Sliding Glass Doors.
2. AAMA 302.8, Specification for Aluminum Windows.
3. AAMA 701-702, Voluntary Specification for Pile Weatherstrip and Replaceable Fenestration Weatherseals.
4. AAMA GS-001, Guide Specifications for Aluminum Architectural Windows.

B. American Society for Testing and Materials, (ASTM).
1. ASTM B 117, Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM B 221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. ASTM D 522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
4. ASTM D 523, Test Method for Specular Gloss.
5. ASTM D 968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
6. ASTM D 1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
7. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
8. ASTM D 2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
9. ASTM D 4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
10. ASTM E 283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
11. ASTM E 330, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
12. ASTM E 331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.

C. Federal Specification, (FS).
FS RR-W-365, Wire Fabric.

D. National Association of Architectural Metal Manufacturers, (NAAMM).
NAAMM Metal Finishes Manual for Architectural and Metal Products.

E. Uniform Building Code, (UBC).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Installer's Qualifications:

1. Installer shall be certified by the manufacturer of the aluminum windows to install the product accepted for this Project. Installer shall provide evidence of at least five years installing similar product to the product accepted for this Project as well as at least three references for projects where the exact product accepted for this Project has been successfully installed.
2. Submit name and qualifications of the installer to the ENGINEER.

C. Component Supply and Compatibility:
1. Obtain all products included in this Section regardless of the component manufacturer from a single aluminum window manufacturer.
2. The aluminum window manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the aluminum window manufacturer.

1.4 SUBMITTALS

A. Shop Drawings:
Fabrication and installation of aluminum window units and associated components of the Work. Include wall elevations at 1/4-inch scale, typical unit elevations at 1-inch scale and full-size detail sections of every typical composite member. Show anchors, hardware, operators and other components not included in manufacturer's standard data, including glazing details. Indicate clearly on the Shop Drawings, all deviations from Contract Documents.

B. Product Data:
1. Copies of manufacturer's specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the Work. Include certified test laboratory reports as necessary to show compliance with the requirements.
2. Copies of manufacturers' specifications and installation instructions for required materials and components, which are not included in the other submittals, specified in other Sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.

C. Samples:
1. Samples of each required aluminum color and finish, on 12-inch long sections of extrusion shapes as required for the aluminum window units.
2. Samples will be reviewed by ENGINEER for color and texture only. Com-pliance with all other requirements is the exclusive responsibility of CONTRACTOR.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete

in ample time to prevent delay of that Work.

B. Storage and Protection:
Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

Design Criteria:

A. Except as otherwise shown or specified, the requirements for aluminum windows, and the terminology and standards of performance and fabrication workmanship, are those specified and recommended in AAMA 101, and the applicable general recommendations published by Architectural Aluminum Manufacturer's Association, National Association of Architectural Metal Manufacturers and Aluminum Association.
B. All custom and standard features and finishes offered by the named manufac-turers shall be made available to ENGINEER from any “or equal” manufacturer submitted by CONTRACTOR.
C. Custom High Performance Insulated Thermal-Barrier Aluminum Windows:
    1. Performance and Testing: Except as otherwise specified, comply with the air infiltration tests, water resistance tests and applicable load tests specified in AAMA 101 for the type and classification of aluminum window units required in each case.
    2. Comply with Architectural Performance Class and Section 4 “Optional Performance Grades” of AAMA 101 Group II-Compression Seal Window Products AP-AW50, Architectural.
    3. Design Pressure:
        a. Provide uniform structural test pressure of 75 pounds per square foot.
        b. Air Infiltration Test, ASTM E 283: Maximum infiltration 0.065 cubic feet per minute per linear foot of operating ventilator when tested at 6.24 pounds per square foot differential pressure.
        c. Water Penetration Test, ASTM E 331: No water penetration for 15 minutes when window is subjected to rate of flow of five gallons per hour per square foot with differential pressure across window unit of ten pounds per square foot.

d. Wind Load Test, ASTM E 330: Minimum 50 pounds per square foot positive and negative load for ten seconds. Maximum deformation of frame or sash member L/175 of span length.

4. Testing: Wherever manufacturer's standard window units comply with the requirements and have been tested in accordance with the specified tests, provide certification by the manufacturer of compliance with such tests; otherwise, perform the required tests through a recognized testing laboratory or agency and provide certified test results.
5. Provide aluminum window system, and insulated project-in windows to withstand thermal expansion and contraction movements resulting from not less than an ambient temperature range of 10 to 100°F, which may cause an aluminum window system and insulated project-in window temperature range of 10 to 100°F. Limit the deflection as for wind pressure loading. Thermal movements shall not cause permanent deformation, cracking, opening of joints, undue stress on fasteners, or other effects detrimental to weathering performance.
6. The design of the aluminum window system as shown and specified is intended to prevent excessive condensation on the indoor faces of the Work, with the heating and ventilating system in operation, and under the following conditions. Provide aluminum window systems that achieve and maintain this design intention:
    a. Outdoor: Ambient temperature 10 °F, 50 miles per hour wind.
    b. Indoor: Ambient temperature of 70 °F, relative humidity of 100 percent.
    c. Excessive condensation is defined as visible water or frost.
7. Provide internal drainage to lead all infiltrated water to the exterior through weep slots.
8. Other Loading: Applicable requirements of the current Georgia Uniform Building Code.

2.2 MANUFACTURERS

Manufacturers: Provide products of one of the following:

A. Traco Architectural Systems, Inc.
B. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Aluminum Extrusions: Alloy and temper, ASTM B 221, 6063-T5 and not less than 1/8-inch thickness at any location for mainframe sash members and tube supports. Vertical mullions and support clips as recommended by the window manufacturer.

B. Thermal Separator: Interior and exterior aluminum frame sections shall be thermally separated by a continuous urethane connector.

C. Fasteners: Stainless steel, guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
   1. Do not use exposed fasteners, except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener, unless otherwise specified.
   2. Provide Phillips flat-heat machine screws for exposed fasteners, unless otherwise specified.

D. Glazing Gaskets: Neoprene or EPDM.

E. Glass and Glazing Materials: Refer to Section 08800, Glass and Glazing.

F. Wire Fabric Insect Screen: 18 by 14 mesh of 0.01-inch diameter aluminum wire, complying with FS RR-W-365, Type VII.

G. Hardware:
   1. Projected-In Windows: Mullion mounted high-pressure die-cast zinc nickel-plated steel pawl cam-action in-line base locking handles with concealed pawl. Provide non-magnetic stainless steel keepers. Baked enamel aluminum color with lacquer finish.
   2. Heavy-duty 6-bar hinges with stainless steel balance arms. Provide sliding pivots with nylon friction-adjustable shoe in a stainless steel track.
   3. Concealed limited opening device.
   4. Manufacturer: Provide the product of the following:
      Truth Division Sealed Power Corporation.

2.4 WINDOW OPERATION

General: The following paragraph defines the operating arrangement for the required types of sash (ventilators) in window units, and specifies minimum provisions for each type.

Project-in Windows: Swing-in, side-hinged vent sash and fixed window combinations as shown, provide operable sash with two balance-support arms, pivots with friction shoes and three cam handle operators; top mounted cam handles for pole operation.

2.5 WINDOW CLASSIFICATION (GRADE)

AP-AW50, Architectural Windows: Provide window units complying with the following:

A. Extruded aluminum-glazing stops of 0.062-inch minimum wall thickness, except 0.050-inch minimum for snap-on type.
B. Hardware and anchors of non-magnetic stainless steel and white bronze.

C. Fabricate units with all main corners and intersections of frame and sash mitered. Provide double tubular frame with hydraulically crimped gusset corner construction. Mortise or cope secondary members to fit, and weld in place with hairline joints.
D. Provide metal thickness as required to withstand performance requirements, but not less than 0.078-inch for frame members.
E. Provide means of drainage for water and condensation, which may accumulate in members of the window units.

2.6 FABRICATION AND ACCESSORIES

A. General: Provide specified manufacturer's standard fabrication and accessories, except to the extent more specific or more stringent requirements are specified. Include complete system for assembly of components and anchorage of window units, and prepare sash for glazing.

B. Sizes and Profiles: The required sizes for window units and the profile requirements are shown. The details shown are based upon standard details by one or more manufacturers. It is intended that similar details by other manufacturers will be acceptable, provided they comply with the size requirements, and with minimum/ maximum profile requirements specified.

C. Coordination of Fabrication: Wherever possible check actual window openings in the construction Work by accurate field measurement before fabrication, and show recorded measurements before fabrication, and show recorded measurements on final Shop Drawings. However, coordinate fabrication schedule with construction progress as directed by CONTRACTOR to avoid delay of the Work. Where necessary, proceed with fabrication without field measurements, and coordinate installation tolerances to ensure proper fit of window units.

D. Provide mullions and cover plates as shown, matching window units and complete with anchors for support to structure and for installation of window units. Allow for erection tolerances and provide for movements of window units due to thermal expansion and building deflections.

E. Provide insect screen unit for each operable exterior sash. Locate screen units on outside of sash. Wherever possible, design window units and hardware to accom-modate screens in a tight-fitting removable arrangement, with a minimum of exposed fasteners and latches, and with aluminum-extruded frame continuous wickets along lower edge of screen for cam handle access.

F. Fabricate screen frames of extruded aluminum tubular-shaped members of 0.040-inch minimum wall thickness, with mitered or coped joints and concealed mechanical fasteners, with removable PVC spline-anchor concealing the edge of the screen fabric, and finished to match the window unit, unless otherwise indicated.

G. Provide serrated sash for pre-shimmed glazing tape.

H. Provide extruded aluminum true-divided mullions, and custom aluminum panning as shown.

2.7 ALUMINUM WINDOW FINISHES

A. Exposed Aluminum Polyvinylidene Fluoride Based Coating: Apply full strength polyvinylidene fluoride based coatings at the factory by coil coating for sheet material and spray coating for extruded or factory-fabricated material. Provide a four-coat system complying with the following:
   1. Alkali clean and hot water rinse all surfaces to receive polyvinylidene fluoride based finish.
   2. Prepare a chemical conversion coating on the surface, using phosphates or chromates followed by a cold-water rinse. Seal with a chromic acid rinse and dry, except where manufacturer recommends another method to achieve greater coating reliability.
   3. Apply a base prime coat of epoxy paint to the prepared surface in its coil form, by reverse roller coating. Fully cure in a gas-fired oven to a dry film thickness of 0.2 to 0.4-mils. Follow with a barrier coat 1.0-mils thick.
   4. Apply color coat containing mica pearlescent or metallic flakes over the barrier coat by roller coating for coil material and airless or Ransburg Elastrostatic Hand Spray for extrusions and fuse at a peak metal temperature of 440°F for a dry film thickness of 0.7-mils for coil coating and 1.2-mils for spray coating so that today dry film is approximately 1.0-mil thick for coil material and 1.5-mil thick for extruded material.
   5. Apply clear fluoropolymer topcoat to provide a dry film thickness of 0.4 to 0.8-mils. The entire system shall have a dry film thickness of 2.6-mils, minimum.
   6. Provide the following physical properties, as proven by appropriate and recognized laboratory test methods acceptable to ENGINEER:
      a. Weathering, ASTM D 4214: Chalking, not more than No. 8, after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      b. Color Change, ASTM D 2244: No greater than 5 N.B.S units after removal of external deposits and after exposure for 5,000 hours in Sunshine Arc Weatherometer XWR using 60/60 cycle.
      c. Humidity Resistance, ASTM D 2247: No blister after 3,000 hours.
      d. Salt Spray, ASTM B 117: Few scattered blisters no larger than ASTM No. 4, and no more than 1/16-inch creep from areas scribed to bare metal after 3,000 hours.
      e. Dry Adhesion: No pick-off when tape tested over 1/16-inch cross hatch.
      f. Wet Adhesion: No pick-off when tape tested over 1/16-inch cross hatch; extruded material only.
      g. Boiling Water Adhesion: No pick-off when tape tested over cross hatch area after one-hour immersion in distilled boiling water.
      h. Water Immersion: No pick-off when tape tested over cross hatch area after immersion in aerated distilled water 80 ±10°F after 500 hours.
      i. Abrasion Resistance, ASTM D 968: Coefficient of abrasion of 67, minimum.

j. Gloss, ASTM D 523: 30 ±5 reflectivity at 60°F.
k. Pencil Hardness, ASTM D 3363: HB-H minimum.
l. Dry Film Thickness: Primer, 0.2 to 0.4-mils, barrier coat, 1.0-mils, color coating, 0.7 to 1.5-mils; clear topcoat, 0.4 to 0.8-mils.
m. Solvent Resistance: 100 Double MEK rubs, minimum.
n. Flexibility, ASTM D 522: No cracking prior to metal fracture.
o. Acid Resistance, ASTM D 1308: Sixteen hour spot test with five percent hydrochloric acid - no effect.
p. Alkali Resistance, ASTM D 1308: Sixteen hour spot test with five percent sodium hydroxide - no effect.

B. Color:
1. Full selection of manufacturer's standard, custom and premium colors for final selection by ENGINEER.
2. ENGINEER will select custom special extended life premium colors for aluminum windows at time of Shop Drawing and sample submission review.

PART 3 - EXECUTION

3.1 INSPECTION

CONTRACTOR shall examine the substrate and conditions under which custom aluminum window system Work is to be installed and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

A. Comply with manufacturer's specifications, installation manuals and recommendations for the installation of window units, hardware, operators, and other components of the Work.

B. Erection Tolerances:
1. Limit variations from plumb, level or dimensioned angle to the following:
a. 1/8-inch maximum deviation in story height or in 10-foot vertical or angular run, and in 20-foot horizontal runs.
b. 1/4-inch maximum deviation in 40 foot runs, all directions.
2. Limit variations from theoretical member locations shown, based on established floor lines and column lines, including variations from plumb and level, to the following:
a. 3/8-inch total maximum deviation for members at all locations.
b. 1/8-inch maximum change in deviation for members for ten foot runs, all directions.

3. Limit offsets in end-to-end and edge-to-edge alignments of adjoining and consecutive members, which form planes, continuous runs and profiles, to the following:
    a. 1/16-inch maximum offset in flush alignment, including members, which are to be 1/2-inch or less out-of-flush, and including members, which are separated 2-inches or less by a reveal or protrusion in the plane of the aluminum window wall.
    b. 1/8-inch maximum offset in alignments, which are to be out-of-flush by more than 1/2-inch, or separated by a reveal or protrusion of more than 2- inch width.

C. Anchor units securely in place. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

D. Refer to Section 07900, Caulking and Sealants, for compounds, fillers and gaskets to be installed concurrently with window units.

E. Do not install component parts, which are observed to be defective in any way, including warped, bowed, dented, abraded and broken members, and including glass with edge damage.

F. Do not cut, or trim, component parts during erection, in a manner, which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance of the aluminum window wall. Return component parts, which require alteration to the shop for refabrication, if possible, or for replacement by new parts.

G. Install component parts level, plumb, true to line and with uniform joints and reveals. Secure to structure with non-staining and non-corrosive shims, anchors, fasteners, spacers and fillers. Use erection equipment, which will not mar or stain finished surfaces, and will not damage the component parts.

H. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials before installation, wherever there is the possibility of corrosive or electrolytic action.

I. Anchor component parts securely in place as shown, by bolting, or other permanent mechanical attachment system, which will comply with performance requirements and permit movements, which are intended or necessary. Install slip-joint linings to ensure movement as intended or necessary.

J. Clean debris, dust and other substances from behind the aluminum window wall as it is erected, and provide temporary closures if necessary to prevent the accumulation of such substances in the void spaces behind the aluminum window walls.

K. Install thermal barrier between pressure plate and mullion.

L. Attach pressure plate with screws. Install snap covers over pressure plates.

M. Install glazing using dry glazing retainers, which provide a firm but resilient clamping grip on the glazing.

N. Adjust operating sash and hardware to provide a tight fit at contact points and at weatherstripping for smooth operation and weathertight closure.

O. Refer to Section 08800, Glass and Glazing, for installation requirements.

P. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.

Q. Advise CONTRACTOR of protective treatment and other precautions required through the remainder of the construction period, to ensure that window units will be without damage or deterioration, other than normal weathering, at the time of Final Completion.

R. Maintain the aluminum window wall in a clean condition throughout the construction period, so that it will be without any evidence of deterioration or damage, other than the effects of normal weathering, at the time of Final Completion. Select methods of cleaning which will promote the achievement of uniform appearance and stabilized colors and textures for materials that weather or age with exposure.

S. CONTRACTOR shall advise ENGINEER, in writing, of protection and surveillance requirements that CONTRACTOR shall provide at no additional cost to the OWNER, to ensure that the aluminum windows Work will be without deterioration or damage at the time of Final Completion by OWNER.

T. Remove and replace with new material aluminum window components, which have been damaged, including finish, beyond successful repair, as directed by ENGINEER. Repair minor damage.

U. Immediately before the time of Final Completion, clean the aluminum windows thoroughly, inside and out. Demonstrate proper cleaning methods to OWNER'S maintenance personnel during this final cleaning.

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

W. Remove all materials and debris and leave the Site of the Work in clean condition.

3.3 FIELD QUALITY CONTROL

A. Water Penetration Test: Perform test in accordance with NAAMA Standard FC-1: "Field Check for Water Leakage of Metal Curtain Walls", except limit test area to one bay wide

(but not less than 20 feet or more than 40 feet) by one story high, located from mid-bay to mid-bay and from mid-story-height to mid-story-height.

B. Depending upon the prevalence or absence of leakage in the initial water penetration test, and upon measures adopted by the aluminum window wall CONTRACTOR to eliminate sources of leakage from subsequently erected work, the ENGINEER will determine the necessity, and scope of, additional tests. In no case will the total of tested area amount to less than one percent, nor more than ten percent of the aluminum window wall area, except as subsequently authorized by the ENGINEER.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all finish hardware including door butts, hinges and closures. 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. Related Work Specified Elsewhere:

Section 08110, Steel Doors and Frames
Section 08331, Overhead Rolling Doors

1.2 QUALITY ASSURANCE

A. Provide hardware in compliance with the local building code requirements. Also comply with NFPA101 Life Safety Code and ANSI A117.1 where applicable.

B. Provide hardware for fire rated openings in accordance with NFPA80, Fire Doors and Windows and NFPA105 Smoke and Draft Control Door Assemblies.

C. Provide the services of a finish hardware supplier who has been furnishing hardware in the project's vicinity for a period of not less than two (2) years and is an experienced hardware consultant (AHC). The consultant shall be available during the course of the work to the Engineer and Contractor.

1.3 SUBMITTALS

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

A. Complete schedule of hardware. Using the format of this specification, indicate type, number location, and finish of each item. Include manufacturers name and model description, fastening devices, and complete keying schedule. Reference architect's door designation. Submit five (5) copies.

B. Cross-reference between door number and hardware headings.

C. When requested submit physical samples of each item of hardware showing manufacturers name, model, and finish.

D. Furnish templates and approved schedule to each related manufacturer of equipment which require same for the fabrication of their material.

1.4 DELIVERY STORAGE AND HANDLING

A. Deliver finish hardware to project site in manufacturers protective packaging. All items are to be marked to indicate door opening number, hardware schedule number, or other identifying marks.

B. Store hardware in secure lock-up area that is dry and lighted.

1.5 WARRANTY

A. Warrant door closers against failure due to defective materials and workmanship for a period of five (5) years beginning at date of substantial completion. Closers judged defective during this period shall be replaced or repaired at no cost to the owner.

B. All other warranties and bonds are to be in accordance with the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 FINISH

A. Finish, unless otherwise indicated, shall be US26D, satin chrome.

B. Door closers shall be spray-painted for finish to match adjacent hardware.

2.2 KEYING

A. All new cylinders shall be keyed to a new Master Key System.

B. Provide the following number of keys:
   1. Three Change Keys per lock.
   2. Six Master Keys.

2.3 HINGES

A. Acceptable manufacturers:
   1. H. Soss
   2. Stanley
   3. Hager

B. Hinges shall be the types, materials, sizes, and finishes indicated in Finish Hardware Schedule.

   Provide 4-1/2 inch x 4-1/2 inch size on doors up to 3'0" wide. Provide 5-inch x 4-1/2 inch on doors over 3'0" wide. Provide 1-1/2 pair on doors up to 7'6" and one additional hinge for each 2'6" of door thereafter. All exterior outswing doors shall have N.R.P. feature. Provide hinge types as listed in hardware sets.

2.4 LOCKSETS AND LATCHES

A. Acceptable Manufacturers:
   1. Schlage Lock Company
   2. Sargent & Company
   3. Corbin Div. of Emhart
   4. Russwin Div. of Emhart
   5. Best Lock Company
   6. Yale Security
   7. Or equal.

B. Acceptable lockset series and design:
   1. L9000 Series - 06B Design
   2. 18-8100 Series - LNL Design
   3. 9500 Series - 977L4 Design
   4. 5000 Series - L4 Newport Design
   5. 35H Series - 14G Design
   6. High Security SL8700 Mortise Locket Augusta – ASL Lever Handles and Trim
   7. Or equal.

C. Cylinders shall be mortise, six pin type complete with cam and tail piece for exit devices.

2.5 SURFACE MOUNTED DOOR CLOSERS

A. Acceptable manufacturers and product:

1. Rixson-Firemark, Inc.; 2020 Series x SNB
2. LCN
3. Or equal.

B. All surface closers shall be of one manufacturer. The closers shall be nonhanded and nonsized. They will be hydraulically controlled and full rack and pinion operation. They shall have cast iron bodies and will have adjustments for backcheck, general speed, and latch speed.

C. Provide mounting plates as required, hex nuts and bolts for application to hollow metal doors, and thru bolts for application to wood doors.

2.6 STOPS AND MISCELLANEOUS

A. Acceptable manufacturers:
1. Quality Hardware
2. H. B. Ives Co.
3. Baldwin Hardware Corp.
4. Glynn-Johnson Part of Worldwide Ingersoll-Rand Corporation
5. Or equal.

B. Types as indicated in Hardware Schedule.

2.7 BOLTS

A. Acceptable manufacturers:
1. Quality Hardware
2. H. B. Ives Co.
3. Baldwin Hardware Corp.
4. Or equal.

B. Flush bolts shall be 1" x 6-3/4" brass, rectangular front, per lengths indicated, with 3/4" throw. Furnish bottom strike and top strike plate.

C. Bolts and accessories for use on fire-rated doors shall be Underwriters' Laboratories listed.

2.8 FLAT GOODS

Acceptable manufacturers:
A. Quality Hardware Company
B. Baldwin Hardware Corp.
C. H. B. Ives Co.
D. Accurate
E. Or equal.

2.9 THRESHOLDS AND WEATHERSTRIP

Acceptable manufacturer:

A. Reese
B. Pemko
C. National Guard
D. Or equal.

2.10 WEATHERSTRIPPING: HEAD, JAMBS AND SILL

A. Acceptable manufacturers shall include National Guard Products, Inc., Pemko Mfg. Company, Zero Weatherstripping Company, Inc., Hager or equal.

B. The types are as indicated on the hardware Schedule.

2.11 SILENCERS

Silencers shall be rubber, self-lipping, cream color. Provide three silencers for single doors and 2 silencers for pairs of doors.

2.12 EXIT PANIC DEVICE

A. Exit Doors: Where required by governing authorities having jurisdiction at the Site, provide panic exit devices, of the type required, including UL labels.

B. Fire Doors: Where shown or specified as a fire-resistance-rated door, provide units listed and labeled by UL, to comply with the fire-resistance-rating and size of door shown.

C. Strikes: Provide manufacturer's standard wrought stainless steel jamb-mounted top latch bolt and bottom latch bolt for each location and use shown to allow independent opening and closing of each leaf of double doors with panic exit devices; complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.

D. Lock Throws: Provide minimum of 3/4-inch latch bolt throw complying with UL List of Inspected Fire Protection Equipment and Materials and NFPA 80 requirements.

E. Provide concealed vertical rod type exit device and mortise type exit devices as specified.

F. Provide the following features and materials:
   1. Latch Bolt: Two-piece; mechanical; anti-friction, stainless steel.
   2. Dead Bolt: One-piece, stainless steel with two enclosed hardened-steel roller armor pins.
   3. Case: Wrought steel, zinc dichromatized.
   4. Cylinders: High-security; brass; pick- and drill-resistant; ANSI/BHMA A156.5 - E09211A.

5. Armor Front: 8-inches by 1-1/4-inches wide, minimum; steel.
6. Escutcheon: 8-inches by 2-1/2-inches wide by 3/16-inches thick, minimum; stainless steel, US 32D.
7. Hubs: Sintered steel, copper infiltrated.
8. Crossbar: Oval, seamless with interlocking expansion collets and roll pins; knurled, satin stainless steel, 0.062-inches minimum thickness, with steel reinforcing tube.
9. Concealed bolts: Minimum 1/2-inch diameter, stainless steel.

G. Backset: Provide minimum backset of 2-3/4-inches.

H. Finish: US 32D satin.

I. ANSI/BHMA: A156.3, Type 3 and Type 8, Grade 1; F08, entrance by lever, key locks or unlocks lever for entrances shown as accessible to people with disabilities as required by ADAAG; and F05, entrance by thumb piece, key locks or unlocks thumb piece.

J. Products and Manufacturers: Provide one of the following:
1. 1530-L8 (F) and -T8 (F) Series Mortise Exit Devices and 1520(F) CVR Concealed Vertical Rod Exit Devices; with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece/Handle/Cylinder Unit by Yale Security, Incorporated, Division of Yale Security Group.
2. Or equal.

PART 3 - EXECUTION

3.1 PRELIMINARY

A. Receive, store in temporary bins, and be responsible for all finish hardware. Tag, index, and file all keys temporarily during construction.

B. Check all hardware upon arrival on job site against approved Finish Hardware Schedule. Function of hardware shall be examined against the job site conditions and interferences. If exceptions in these regards are found, notify Architect at once and retain subject hardware in its original packing carton. Adjustment and/or substitutions shall be made only as authorized by the Engineer.

3.2 INSTALLATION

A. Install hardware to doors as listed in the door schedule. Comply with "Recommended Locations for Builders Hardware for Custom Steel Doors and Frames", as published by The Door and Hardware Institute, except for height locations below. Application shall be by skilled workmen, who work with proper equipment, shall be in accord with manufacturer's instructions,

fit to work of others accurately, applied securely, and adjusted properly. Hardware let into work of others shall be neatly done from template and shall fit perfectly. Exercise care not to injure work of others.

Locksets and latchsets: Centered 40" A.F.F.
Deadlocks: Centered 60" A.F.F.
Push Plates: Centered 48" A.F.F.
Pulls: Centered 48" A.F.F.

B. Install finish hardware to template. Cut and fit substrate to avoid substrate damage or weakening. Cover cut-outs with hardware item. Mortise work to correct location and size without gouging, splintering, or causing irregularities in exposed finished work.

C. Where cutting and fitting is required on substrates to be painted or similarly finished, install, fit, and adjust hardware prior to finishing, and then remove and place in original packaging. Reinstall hardware after finishing operation is completed.

D. Attach thresholds with flathead screws in expansion shields spaced at 24" o.c. maximum and symmetrical with the center of door opening.

E. Attach door closers to door, whether wood or metal, with hex nut and bolt assemblies. Where closers have stop function, install closer to stop the door before striking obstructions.

F. All locksets, specialty locks and cylinders shall be installed so as to be made operable via insertion of their keys held with cut edges up, smooth edges down.

G. Install push/pull sets so as to conceal all back mounted "pull" handle attachments from view on the "push" side of doors.

3.3 CLEANING AND ADJUSTING

A. At time of hardware installation, adjust each hardware item to perform function intended. Lubricate moving parts with lubricant acceptable to hardware manufacturer.

B. Prior to "Date of Substantial Completion", readjust and relubricate hardware. Repair or replace defective materials. Clean hardware as recommended by manufacturer to remove dust and stains.

3.4 FASTENINGS

A. All exposed screws shall be Phillips head, finished to match item and sized to suit job requirements.

B. Surface applied items such as closers and overhead holders shall be applied with hex nut and bolt assemblies.

3.5 OPERATION AND ADJUSTMENT

A. After installation, all templates, instruction sheets, installation details, and special tools shall be turned over to the Engineer at Final Acceptance of the building.

B. After Final Acceptance, the hardware supplier shall be available to instruct Owner's designated personnel in the proper adjustment and maintenance of hardware and finishes.

3.6 COORDINATION

Fully coordinate finish hardware installation with other specified systems which relate to installation and ultimate coordinated function intended for a complete operating system.

3.7 HARDWARE SCHEDULE

Hardware Sets: - Each Door

	Set NO. 1 Single Egress Doors	Doors 101, 104		
3 PR	Butts	4-1/2 x 4-1/2	626	Hager
1	Latchset	SL87001530-L8 (F) and –	626	Yale Security
1	Panic Exit Device	T8	626	Yale Security
1	Closer	4040XP	Al	LCN
1	Overhead Holder and Stop	HD100H (ADJ)	ALUM	Glynn Johnson
3	Silencers	GJ 64	Al	Glynn Johnson
1	Threshold	171B	Al	PEMKO
	Weatherstripping	2891 DPK		PEMKO
1	Drop Seal	434APKL	Al	PEMKO

	Set NO. 2 Double Egress Doors	Doors 103		
6 PR	Butts	4-1/2 x 4-1/2	626	Hager
1	Latchset	SL87001530-L8 (F) and –	626	Yale Security
1	Panic Exit Device	T8 and 1520(F) CVR	626	Yale Security
2	Closers	4040XP	Al	LCN
2	Overhead Holder and Stop	HD100H (ADJ)	ALUM	Glynn Johnson Glynn Johnson
6	Silencers	GJ 64	Al	PEMKO
1	Threshold	171B	Al	PEMKO
	Weatherstripping	2891 DPK		PEMKO
2	Drop Seal	434APKL	Al	PEMKO
1	Manual Flush Bolt	GJ FB30	Al	Glynn Johnson
1	Coordinator	COR 1, 2 and 3 Series	Al	Glynn Johnson
1	Astragal	No. 357 Series	Al	PEMKO
	Set NO. 4 Interior Single Door	Doors 106		
3 PR	Butts	4-1/2 x 4-1/2	626	Hager
1	Mortise Exit Device	1530-L8 (F) and -T8 (F) Series Mortise Exit Devices with Escutcheon Trim and Augusta - ASL Lever Handles and Thumbpiece /Handle/Cylinder Unit 404QH		Yale Security
1	Closers	171B	Al	LCN
1	Threshold	331Es	ALUM	PEMKO
1	Dome Stop	No. 434APKL	ALUM	Quality
1	Stripping And Seals	SR 64	Al	PEMKO
3	Silencers		Al	Ives

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SECTION 08800
GLASS AND GLAZING

PART 1 - GENERAL

1.1 SCOPE:

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all glass and glazing. All glass and glazing shall be installed in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Types of work in this section include glass and glazing for: Window units, Entrances and other doors, not indicated as "preglazed".
   1. Clear, insulating, float glass.
   2. Structural and non-structural glazing sealants.
   3. Miscellaneous glazing, spacers, tapes, and other materials.

C. Related Work Specified Elsewhere:
   1. Section 08110: Steel Doors and Frames.
   2. Section 08513: Aluminum Windows.

1.2 REFERENCES:

A. Standards of the following as referenced:
   1. American National Standards Institution (ANSI).
   2. American Society for Testing and Materials (ASTM).
   3. Associated Laboratories, Inc. (ALI).
   4. Consumer Products Safety Commission (CPSC).
   5. Flat Glass Marketing Association (FGMA).
   6. Glass Tempering Association (GTA).
   7. Insulated Glass Certification Council (IGCC).
   8. Laminators Safety Glass Association (LSGA).
   9. National Association of Mirror Manufacturers (NAMM).
   10. Sealed Insulating Glass Manufacturer's Association (SIGMA).
   11. Safety Glass Certification Council (SGCC).
   12. Underwriters' Laboratories, Inc. (UL).

B. Industry standards:
   1. ANSI: Safety Performance Standards and Methods of Tests for Safety Glazing Materials Used in Buildings, Z97.1-1984.
   2. ALI: Directory, March 1981 edition.
   3. CPSC: Safety Standard for Architectural Glazing Materials, 16CFR Part 1201, January 1986 edition.
   4. FGMA: Glazing Manual, 1986 edition and Sealant Manual, 1983 edition.
   5. GTA: Engineering Standards Manual.

6. IGCC: Certified Products Directory, August 1980 edition.
7. NAMM: Mirrors, Handle with EXTREME Care.
8. LSGA: Standards Manual.

1.3 SYSTEM DESCRIPTION:

A. Provide glass and glazing that has been produced, fabricated and installed to withstand normal thermal movement, wind loading and impact loading (where applicable), without failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glass and glazing materials and other defects in the work.
   1. Normal thermal movement is defined as that resulting from an ambient temperature range of 120 degrees F (67 degrees C) and from a consequent temperature range within glass and glass framing members of 180 degrees F (100 degrees C).
   2. Deterioration of insulating glass is defined as failure of hermetic seal due to other causes than breakage which results in intrusion of dirt or moisture, internal condensation or fogging, deterioration of protected internal glass coating, if any, resulting from seal failure, and any other visual evidence of seal failure or performance.

B. Design requirements:
   1. Comply with wind load criteria specified by manufacturer.
   2. Maximum allowable deflection: Not to exceed L/175 or 3/4", whichever is less at rated loads.

1.4 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. Manufacturer's technical data for each glazing material and fabricated glass product required, including storage and handling procedures, installation and maintenance instructions, and performance characteristics.

B. Shop drawings: Coordinate shop drawing submittal with major related sections. Indicate location of each lite according to size, thickness, required fabrication, color or coating, heat treatment, and other items specified below.

C. Samples: Submit, for verification purposes, 12" square samples of each type of glass indicated and 12" long samples of each color required and each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative of adjoining framing system in color.

D. Quality control submittals:

1. Framing manufacturer's approval: Indicate by letter prior to submission of shop drawings stating authorized representative of storefront framing manufacturer has reviewed and approved details, including glass bite, clearances, and glazing methods.
2. Submit calculations indicating compliance with wind load criteria bearing seal of licensed professional engineer, registered in State of Georgia.
3. Certificate: Submit certificates from respective manufacturers attesting that glass and glazing materials furnished for project comply with requirements.
4. Separate certification will not be required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authorities having jurisdiction.
5. Compatibility and Adhesion Test Report: Submit statement from sealant manufacturer indicating that glass and glazing materials have been tested for compatibility and adhesion with glazing sealants and interpreting test results relative to material performance, including recommendations for primers and substrate preparation needed to obtain adhesion.
6. List of fabricators for tempered units, insulating units, and spandrel panels; indicate capability of complying with specified requirements.

1.5 QUALITY ASSURANCE

A. Glazing Standards: Comply with recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual" except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this section or other referenced standards.

B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for category II materials.

C. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component pane of units with appropriate certification label of inspecting and testing organization indicated below:
   1. Insulating Glass Certification Council (IGCC)
   2. Associated Laboratories, Inc. (ALI)

D. Single Source Responsibility for Glass: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer or fabricator for each kind and condition of glass indicated and composed of primary glass obtained from a single source for each type and class required.

E. Preinstallation conference:

1. Prior to installation of exterior glass and glazing materials, preglazing conference will be held to review work to be accomplished.
2. Contractor, glazing subcontractor, and all other sub-contractors concerned with glass and glazing and adjacent construction installation shall be present.
3. Notify Engineer at least three days prior to meeting.
4. Verify all required submittals have been reviewed; verify acceptance of sample panel.
5. Record minutes of meeting; distribute to attending parties.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes.

B. Where insulating glass units will be exposed to substantial altitude changes, avoid hermetic seal ruptures by complying with insulating glass fabricator's recommendations for venting and sealing.

C. Store glazing materials indoors in cool, dry area, off floor, equally supported to prevent stress and breakage.

D. Movement of partially unpacked cases is prohibited. Unpack glazing materials in accord with manufacturer's product data for type of material being handled. Stack individual lites as recommended by manufacturer.

E. Handle insulating units without rotating, warping, or "cartwheeling" units. Prevent damage to glazing material or edge seal.

1.7 PROJECT CONDITIONS

Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation or other causes.

1.8 WARRANTY

A. Thermal insulating units: Warrant from failure due to loss of edge seal for ten year period; begin at Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS

Clear, Insulating, Float Glass Units:

1. Uncoated, Monolithic, Clear, Float Glass: Provide clear glass in compliance with ASTM C 1036, Type I (transparent glass, flat), Class 1 (clear), Quality q^3 (glazing select).
2. Insulating Glass Units: Provide preassembled units consisting of two lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class C units, permanently and hermetically sealed together at edges with spacers and sealant.
3. System Sealing: Dual seal with polyisobutylene primary sealant and silicone secondary sealant, complying with ASTM C 1249.
4. Overall Unit Thickness and Thickness of Each Lite:
   a. Overall Thickness: 1-inch.
   b. Each Lite: 1/4-inch.
5. Physical Properties:
   a. Exterior Appearance: Clear.
   b. Visible Light Transmittance: 78 percent, minimum.
   c. Solar Heat Gain Coefficient: 0.70.
   d. Outdoor Visible Light Reflectance: 15 percent.
   e. Shading Coefficient: 0.81.
   f. Winter Nighttime U-value: 0.48.
   g. Summer Daytime U-value: 0.55.
6. Products and Manufacturers: Provide one of the following:
   a. Advanced Coating Technology
   b. AFG Industries, Inc.
   c. Cardinal IG
   d. Environmental Glass Products
   e. Falconer Glass Industries
   f. Ford Glass Division
   g. Glasstemp, Inc.
   h. Globe Amerada Glass Co.
   i. Guardian Industries Corp.
   j. Hordis Brothers, Inc.
   k. Independent Insulating Glass
   l. Spectrum Glass Products, Inc.
   m. Viracon, Inc.

2.2 GLAZING SEALANTS, TAPES AND GASKETS

A. General:

1. Colors: Provide black or other natural color wherever no other color is available. Wherever material is not exposed-to-view, provide manufacturer's standard color, which has the best overall performance characteristics for the application shown.
   a. Provide manufacturer's standard colors as shown or, if not shown, provide color selected by ENGINEER from manufacturer's standard colors to either blend or contrast with adjoining surfaces.
2. Hardness specified is intended to indicate the general range necessary for overall performance. Submit glazing and sealant manufacturer’s recommendations for

actual hardness for each condition of installation and use. Except as shown or specified, provide glazing materials within the following ranges of hardness (Shore A, fully cured, at 75°F):

a. 15 to 35 for elastomeric compounds and tapes used with rigid stops and frames for large glass sizes (in excess of 100 united inches). Provide material sufficiently hard to withstand exposure to abrasion and vandalism.
b. 25 to 50 for rubber-like curing compounds used with rigid stops and frames for medium and small glass sizes (less than 100 united inches). Provide materials sufficiently hard to withstand impact of moving sash and doors.
c. 35 to 60 for molded gaskets used with rigid stops and frames, depending upon strength needed for application or insertion of units.
d. 75 to 80 for structural gaskets (not supported by stops).
e. Non-Elastomeric Compounds: (Shore A not applicable) 2 to 12 mm penetration for 5.0 seconds of penetrometer needle on nominally cured compound, complying with ASTM D 2451.

3. Provide size and shape of gaskets and preformed glazing units as recommended by the manufacturer and as indicated on approved Shop Drawings.
4. Comply with ASTM C 920 and other requirements for each liquid-applied, chemically curing sealant specified.
5. Where additional movement capability is specified, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement, in compliance with ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements in ASTM C 920 for uses shown.

B. Preformed Butyl Rubber Back-Bedding Mastic Glazing Tape:
1. Preformed tape of polymerized butyl or mixture of butyl and polyisobutylene with inert fillers with built-in spacer of synthetic rubber, solvent-based with minimum 95 percent solids, non-sag consistency, tack-free time of 24 hours or less, paintable, non-staining, complying with AAMA 806.3.
2. Products and Manufacturers: Provide one of the following:
a. Polyshim II Glazing Tape by Tremco, Incorporated.
b. Or equal.

C. Dense Compression Wedge Gaskets:
1. Provide molded or extruded, closed-cell silicone wedge gaskets in compliance with ASTM C 1115, Type C.
2. Products and Manufacturers: Provide one of the following:
a. Dense Silicone Wedge Gaskets SCR-900 by Tremco, Incorporated.
b. Or equal.

D. Exterior, One-Part, Silicone Rubber Sealant:
1. Silicone rubber-based, one-part elastomeric sealant, complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, M, G, A and O.
2. Products and Manufacturers: Provide one of the following:
a. Spectrem I by Tremco, Incorporated.

b. 863 Architectural Silicone Sealant by Pecora Corporation.
c. Or equal.

E. Structural Silicone Sealant:
1. Provide a one-component, self-priming, shelf-stable, neutral-cure, elastomeric adhesive complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT, G and A, and specifically formulated for silicone structural glazing complying with the following as-cured physical properties, after seven days at 77°F and 50 percent relative humidity:
2. Durometer Hardness, Shore A, points; ASTM D 2240: 27 to 40.
3. Ultimate Tensile, ASTM D 412: 225 to 350 psi.
4. Ultimate Elongation, ASTM D 412: 525 to 550 percent.
5. Tear Strength, Die B; ASTM D 624: 40 to 49 ppi.
6. Peel Strength, ASTM C 794: 30 to 40 ppi.
7. Products and Manufacturers: Provide one of the following:
a. DOW CORNING 995 Silicone Structural Adhesive by Dow Corning Corporation.
b. 895 Silicone by Pecora Corporation.
c. Or equal.

2.3 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standards, requirements of manufacturers of glass glazing materials for applications shown, and approved Shop Drawings. Provide materials with a proven record of compatibility with surfaces shown and specified.

B. Setting Blocks: Elastomeric material, 80 to 90 Shore A durometer hardness, with proven compatibility with sealants used in the Work and as recommended by the glass manufacturer.

C. Spacers and Edge Blocks: Elastomeric blocks or continuous extrusions, with a Shore A durometer hardness recommended by glass manufacturer to maintain lites in place and to limit lateral movement for installation shown, and with proven compatibility with sealants used in the Work.

D. Cylindrical Glazing Sealant Backing: Closed-cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam complying with ASTM C 1330, Type O (open-cell material), proven to be compatible with sealants used, flexible and resilient, with 5 to 10 psi compression strength for 25 percent deflection.

E. Cleaners, Primers and Sealers: Type recommended by sealant, gasket and glass manufacturer.

2.4 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

Glass manufacturer's recommended glazing channel dimensions are intended to provide for necessary minimum bite on the glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances.

2.5 SOURCE QUALITY CONTROL

A. To the greatest extent possible, provide each type of glass glazing materials from one manufacturer.

B. Providing insulating glass with a certified Class A rating according to SIGMA.

C. Obtain glass and sealant test results for product test reports from qualified testing agencies regularly engaged in the business of testing glass and sealant products.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean the glazing channel, or other framing members to receive glass, immediately before glazing. Remove coatings, which are not firmly bonded to the substrate. Remove lacquer from metal surfaces wherever elastomeric sealants are used.

B. Apply primer or sealer to joint surfaces wherever recommended by sealant and glass manufacturer.

3.2 INSTALLATION

A. General:
   1. Comply with combined recommendations of glass, window and glazing products manufacturers and other materials used in glazing, except where more stringent requirements are shown or specified, and as shown on approved Shop Drawings.
   2. Comply with GANA, Glazing Manual, except as shown and specified otherwise, and except as specifically recommended otherwise by the manufacturers of the glass glazing materials, as accepted by ENGINEER on approved Shop Drawings.
   3. Inspect each piece of glass immediately before installation, and discard all that have observable edge damage or face imperfections.
   4. Unify appearance of each series of lights by setting each piece to match others as nearly as possible. Inspect each piece and set with pattern, draw and bow oriented in the same direction as other pieces.
   5. Install sealants as recommended by sealant manufacturers, and as recommended on approved Shop Drawings.

B. Tape and Sealant Glazing:
   1. Place setting blocks in sill rabbets, sized and located to comply with referenced glazing publications. Set blocks in thin course of compatible sealant for heel bead. Position glass on setting blocks and press against tape for full contact.

2. Provide spacers for glass lites where the length plus width is larger than 4 foot-2 inches. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
3. Provide 1/8-inch minimum bite for spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
4. Provide edge spacers are shown on approved Shop Drawings and as required to prevent glass lites from moving sideways in glazing channel.
5. Cut glazing tape to length and set against permanent stops. Install horizontal strips first, extending over width of opening, before applying vertical strips.
6. Remove paper backing from tape. Place glazing tape on free perimeter of glass. Install tapes continuously. Do not stretch tape to make them fit openings. Place joints in tapes at corners of openings with adjoining lengths butted together, not lapped. Seal butt joints of tape with joint sealant.
7. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
8. Install removable stop, avoiding displacement of tape, and exert pressure on tape for full continuous contact. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Calk space above glazing tape to top of glazing stop. Tool exposed surfaces of sealant compounds to provide a substantial "wash" away from the glass.
9. Clean and trim excess glazing materials from the installation, and eliminate stains and discolorations.
10. Where wedge-shaped gaskets are driven into one side of the channel to pressurize the sealant or gasket on the opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when subjected to dynamic movement. Anchor gasket to stop with matching ribs, or by proven adhesives, including embedment of gasket tail in cured heel bead. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
11. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended on approved Shop Drawings and to prevent corners from pulling away; seal corner joints and butt joints with sealant as recommended by gasket manufacturer and as shown on approved Shop Drawings.

C. Dry Gasket Glazing: Install glass in gaskets as recommended by the glass and window manufacturer.

D. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

E. Protect exterior glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers of any type to surfaces of glass.

F. Remove and replace glass, which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.

G. Maintain glass in a reasonably clean condition during construction, so that it will not be damaged by corrosive action and will not contribute (by wash-off) to the deterioration of glazing materials and other work.

H. Remove non-permanent labels and wash and polish glass on both faces not more than four days prior to Substantial Completion. Comply with glass manufacturer's recommendations for cleaning.

3.3 FIELD QUALITY CONTROL

A. Watertight and airtight installation of each piece of glass is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors) without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and air-tight, deterioration of glazing materials and other defects in the Work.

B. After nominal cure of exterior glazing sealants, which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch hose held perpendicular to wall face, 2 foot-0 inches from joint, connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 foot-0 inches per minute.

C. Test approximately five percent of total glazing system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct tests in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

D. Repair glazing installation at leaks or, if leakage is excessive, replace glazing sealants as directed by ENGINEER.

E. Wherever nature of observed leakage indicates the possibility of inadequate glazing joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints have been fully cured, followed by natural exposure through both extreme temperatures, and returned to the range of temperature in which it is feasible to conduct testing. Repair or replace Work as required and directed by the ENGINEER.

END OF SECTION

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DIVISION 9

FINISHES

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SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 SCOPE

A. This Section of the Specifications includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the Work.

B. Section includes:
1. Surface preparation to receive finishes.
2. Priming and backpriming interior and exterior finish carpentry.
3. Painting, staining, or otherwise finishing of all surfaces.
4. Finishing millwork.

C. Related Work Specified Elsewhere
1. Section 03300, Cast-In-place Concrete.
2. Section 05120, Structural Steel.
3. Section 05500, Miscellaneous Metal.
4. Section 11520, Circular Gravity Thickener.
5. Section 13125, Metal Building Systems.
6. Section 15050, Basic Mechanical Materials and Methods.
7. Section 15060, Piping and Appurtenances.

1.2 SUBSTITUTIONS

To the maximum extent possible, similar coatings shall be the products of one manufacturer. Guidelines for determination of acceptability of product substitutions are given in Instructions to Bidders. Contractors intending to furnish substitute materials or equipment are cautioned to read and comply strictly with these guidelines.

1.3 SUBMITTALS

A. All submittals and storage and protection provisions shall be in accordance with the requirements of the General Conditions, and the following.
1. Product data:
a. Submit complete list of products for use; indicate compliance with:
1) Mercury-free composition limits.
2) VOC limits, when mixed and thinned.
3) Indicate lead content.

b. Indicate manufacturer, brand name, quality, and type paint for each surface to be finished; correlate to specified item if from other manufacturer than specified item. Refer to the attached sample Paint Submittal Schedule for required submittal format.
c. Include specified manufacturer's data sheets for reference to submitted manufacturer's data sheets.
d. Manufacturer's Safety Data Sheets (MSDS) for materials.
e. Intent of Contractor to use products specified does not relieve him from responsibility of submitting product line.

2. Samples:
   a. Color samples: Submit two sets of color samples from paint manufacturers proposed for use for color selections by Engineer.
   b. Brush-outs:
      1) Prepare actual brush-outs for each color paint, stain, or finish following final color schedule issuance.
      2) Submit brush-outs in duplicate: minimum size, 120 sq. in.
      3) Apply products in number of coats specified for actual Work.
      4) Provide following substrates for brush-outs:
         a) Concrete unit masonry: Paint one face to simulate concrete and masonry.
         b) Hardboard to simulate metals for paint finish.

3. Quality control submittals:

   Certificates:
   a. Indicate interior paints and stains are mercury-free.
   b. Indicate lead content. Lead content in excess of 0.06% by weight of nonvolatile content calculated as lead metal is prohibited.
   c. Indicate compliance with applicable VOC limits when mixed and thinned.

1.4 PROJECT MEETING

Prior to ordering any of the materials covered under this Section, the Contractor, Engineer, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting in accordance with the General Conditions, and review the Work to be performed under this Section.

1.5 PAINTING REQUIREMENTS

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.

A. 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.

B. Shop Primed Products:
   1. 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.
   2. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.
   3. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong primer was applied, that the primer was applied improperly, or has excessively weathered, or the product is otherwise unacceptable.

C. Finish Painted Products:

   Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered, or not of the selected color, repaint as necessary in accordance with the paint system manufacturer's written recommendations.

D. Hardware:

   Remove all electrical plates, surface hardware, fittings and fastenings prior to painting operations. These items are to be carefully stored, cleaned and replaced upon completion of Work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.6 SEQUENCING AND SCHEDULING

A. Schedule and coordinate this Work with other trades and contractors for other bid packages; proceeding until other Work and job conditions are proper to achieve satisfactory results is prohibited.

B. Examine specification sections for various other trades; be thoroughly familiar with Work required in other sections regarding painting.

PART 2 - PRODUCTS

2.1 MATERIAL SCHEDULE

Material schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

2.2 APPLICATION DATA

All applicable data currently published by the paint manufacturer relating to surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It will be the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.

2.3 MATERIALS

A. Paints shall be factory mixed and delivered to the job in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer's instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.

B. Unless otherwise specified, paints shall be of the best grade. All thinners, driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.

C. Paint thinners and tints: Products of same manufacturer as paints or approved by paint manufacturer for use with paint.

D. Shellac, turpentine, patching compounds, and similar materials required for execution of Work: Pure, best quality products.

2.4 COLORS

A. The Engineer will select the colors to be used on the various portions of the Work. Provide color cards for the coatings proposed. Where more than one coat of paint is required, job tint the paint for each undercoat off-shade to show complete coverage.

B. Paint inside of ductwork flat black for entire area visible through ceiling openings. Paint underside of ductwork and other above ceiling items flat black for entire area visible through ceiling openings.

C. Paint exposed pipes and ductwork same as adjacent ceiling surfaces.

2.5 SHOP PAINTING

A. Collectors, motors, ferrous metal surface, appurtenances, etc., shall be primed and painted at the factory before shipment. Supplier shall provide touch up paint for field touch-up after installation. Painting system shall be by Tnemec Company, Inc. or OWNER approved equal.

B. Surface preparation and painting shall conform to the requirements listed below in paint schedule in Section 3.7.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. Installing CONTRACTOR shall be responsible for the touch up painting.

PART 3 - EXECUTION

3.1 GENERAL

A. Adequately protect other surfaces from paint and damage. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.

B. Protection: Cover finished Work of other trades, surfaces not being painted concurrently, and prefinished items.

C. Application of materials in spaces where dust is being generated is prohibited.

3.2 PRODUCT HANDLING

A. Delivery
1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.
2. Each container shall be clearly marked or labeled to show paint identification, paint type and color, date of manufacture, batch number, analysis or contents, identification of all toxic substances, and special instructions.

B. Storage
1. Store only acceptable project materials on the project site.
2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable

federal, state and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.

3. Restrict storage area to paint materials and related equipment.
4. Place any materials which may constitute a fire hazard in closed metal containers and remove daily from the project site.
5. Maintain neat, clean conditions in storage area; remove used rags from work areas at end of each day's work; store rags in closed containers.
6. Close containers at end of each day's Work. Leave no materials open.
7. Safety precautions:
    a. Provide temporary fire protection equipment in materials storage area. Mark fire protection equipment location for quick access.
    b. Prohibit smoking in storage area; post signs in visible location adjacent to and within storage area.

3.3 CLEANING AREA

Construct a temporary shed no smaller than 40 feet wide and 60 feet long for field cleaning, including blasting and priming operations. Maintain this area for all non-fixed painting operations until all such work has been completed and approved. Provide all fixtures and appurtenances required to perform the work including fixtures to support the work off the ground and proper storage facilities.

3.4 ENVIRONMENTAL CONDITIONS

Environmental conditions which affect coating application include, but are not necessarily limited to, ambient air temperature, surface temperature, humidity, dew point and environmental cleanliness. Comply with the manufacturer's recommendations regarding environmental conditions under which coatings may be applied.

3.5 SURFACE PREPARATION

A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease or dust. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in weld ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.

B. 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.

C. Galvanized metal: Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

D. Aluminum: Sand to remove oxides. Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

E. Concrete Surfaces:
1. Fill cracks, holes, and irregularities with cement grout.
2. Remove laitance, oil, grease, dirt, and debris from surfaces. Verify concrete cure time prior to coating application.
3. For all concrete surfaces, the following surface preparation shall be employed:

CC-I - Wash: Wash and scrub all surfaces with a solution of 1-1/2 ounces of soap chips and 1-1/2 ounces of trisodium phosphate in each gallon of water used. Flush away all soap and dirt with clean water. After this washing the surface will be rechecked and any rough areas not suitable for painting shall be sand blasted smooth.

3.6 APPLICATION

A. Conditions: No paint shall be applied upon damp or frosty surfaces, or in wet or foggy weather. No paint shall be applied in temperatures below 40.0 F. or when freezing (32.0 F.) is predicted within 24 hours of application, or under temperature or humidity conditions not recommended by the manufacturer.

B. Surface Preparation: After specified surface preparation, all surfaces shall be brushed free of dust or foreign matter. Surfaces shall be completely dry before any paint is applied.

Apply materials only when moisture content of surfaces is within manufacturer's recommended range.

C. Application: Paint shall be evenly spread in the proper thickness so that there shall be no drops, runs or sagging of the coating. Where runs and drops do occur, they shall be removed and the surface re-coated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer, shall be allowed for the paint to dry before the application of succeeding coats.
1. Apply materials in accord with manufacturer's approved product data to achieve specified DFT.
2. Apply materials using clean brushes, rollers, or spray equipment. Limit paint spraying only to those materials recommended by

manufacturer to be sprayed with no loss of performance, durability, or color.

3. Apply materials at rate not exceeding manufacturer's recommendations for surface being coated, less ten percent for losses.
4. Sand and dust between coats to remove defects visible from 5' - 0" distance. Tint primer and intermediate coats slightly to provide slight contrast.
5. Finish coats: Smooth, free of brush marks, streaks, laps or pile-up of paint, skips, or missed areas.
6. Make coating edges adjoining other materials or colors sharp and clean without overlapping.
7. Primer coats may be omitted for surfaces specified to receive factory applied primer if finish coats are compatible with primer. Substitute bond coat recommended by paint manufacturer for specified primer coat if finish coats are not compatible.
8. Refinish entire partition surface where portion of finish on gypsum board partition is damaged or unacceptable.
9. Backprime exterior and interior finish carpentry and millwork with material specified for prime coat without runs on face; finish cut edges just prior to installation.
10. Seal interior doors' tops and bottoms of with prime coat only; side edges same as faces.
11. Finish exterior door edges same as exterior faces.

D. Protection of Work Area: Use drop cloths or other suitable means to protect other surfaces of the structure or equipment in place. Upon completion of the Work, remove all paint spots from surfaces as directed by the Engineer.

E. Inspection: The Engineer will inspect each coat prior to the application of subsequent coats. If the work is found to be satisfactory, a written order will be given to proceed. Application of additional coats until completed coat has been inspected is prohibited. Only inspected coats of paint will be counted in determining the number of coats applied.

F. Defective Work: Remove and replace, at the direction of the Engineer, any painting work found to be defective or applied under adverse conditions.

3.7 PAINTING SCHEDULE

A. Paint the following items as indicated below, unless the item is stainless steel.

1. Structural steel;
2. Walls and ceiling surfaces affected by improvements to achieve complete coverage;
3. Ductile iron pipe;

4. All exposed metal pipe supports, hangers, expansion joints, pipe guides, flexible couplings, and fasteners;
5. Ferrous metal valves;
6. Equipment as described in equipment specifications;
7. Chemical containment area and pump platform; and
8. All exposed piping including insulated piping, except HDPE.

B. Surfaces not requiring painting:
1. Face brick;
2. Precast concrete (unless otherwise noted);
3. Stainless steel and titanium items;
4. Prefinished surfaces and items; and
5. Concealed ductwork, conduit, and piping.

Painting Schedule

Surfaces	Substrate Materials	Paint Material/Schedule
Ceilings	Exposed Concrete	131
Walls	Concrete	131
	CMU Block	131
Interior Structural Steel	Galvanized Metal	140
	Ferrous Metal	140
All Other Listed Metal Surfaces	Galvanized Metal	141
	Ferrous Metal	141
PVC Roof Drain Piping and Vent Stacks	Polyvinylchloride	150
DI Pipe	Ductile Iron	141
Copper Pipe	Copper	142
Tank Containment Area and Pump Platform	Concrete	132
Circular Thickener Tank	Submerged Concrete	133
Circular Thickening Equipment	Submerged Steel	161
Circular Thickening Equipment	Non-submerged Steel and Ferrous Metals	162

MATERIAL SCHEDULE 131

TYPE: EPOXY

USE: INTERIOR MASONRY AND CONCRETE

SURFACE PREPARATION: CC-I

TNEMEC

FIRST COAT: SERIES 130-6602 ENVIORFILL – 60-80 SQ/FT./GAL

SECOND COAT: SERIES 66HS HI-BUILD EPOXOLINE - 4.0 MILS DRY

THIRD COAT: SERIES 66HS HI-BUILD EPOXOLINE - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

KOPPERS

FIRST COAT: CONCRETE AND MASONRY FILLER

SECOND COAT: HI-GARD EPOXY - 4.0 MILS DRY

THIRD COAT: HI-GARD EPOXY - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Sherwin-Williams Company.

MATERIAL SCHEDULE 132

TYPE: REINFORCED MORTAR NOVOLAC EPOXY LINING

USE: CONTAINMENT AREA AND PUMP PLATFORM

SURFACE PREPARATION: ABRASIVE BLAST TO PROVIDE PROFILE PER NACE 6/ SSPC-SP-13

TNEMEC

FILLER: SERIES 218 MORTARCLAD OR MORTARCAST

PRIMER: SERIES 2395C

BASE COAT: SERIES 2395C MORTAR, MAT AND SATURANT

TOP COAT : SERIES 282 (2 COATS)

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. KOPPERS,
   b. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 133

TYPE: MODIFIED POLYAMINE EPOXY LINING

USE: CONCRETE SLUDGE HOLDING TANK – INTERIOR, IMMERSION

SURFACE PREPARATION: ABRASIVE BLAST TO PROVIDE PROFILE PER NACE 6/ SSPC-SP-13

TNEMEC

FILLER: SERIES 217 MORTARCRETE

SURFACER: SERIES 218 MORTARCLAD – 1/16" TO 1/8"

PRIMER: SERIES G435 PERMA-GLAZE – 15.0 – 20.0 MILS*

TOP COAT : SERIES G435 PERMA-GLAZE – 15.0 – 20.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. KOPPERS,
   b. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 140

TYPE: POLYAMIDE EPOXY

USE: FERROUS METAL SURFACES AND STRUCTURAL STEEL LOCATED INSIDE A BUILDING WHICH ARE NOT SUBMERGED OR LOCATED ABOVE A LIQUID. NOT FOR USE WITH PROCESS EQUIPMENT.

SURFACE PREPARATION: SSPC SP-6

TNEMEC

PRIMER: SERIES 1 OMNITHANE – 2.0 – 5.0 MILS*

FIRST COAT: SERIES 66HS EPOXOLINE II - 6.0 - 8.0 MILS*

SECOND COAT: SERIES 66HS EPOXOLINE II - 6.0 - 8.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 14.5 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. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 141

TYPE: HIGH BUILD EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR FERROUS METAL SURFACES ON ALL MECHANICAL EQUIPMENT AND ACCESSORIES INCLUDING BUT NOT LIMITED TO: PUMPS, VALVING AND OTHER PROCESS EQUIPMENT AND EXTERIOR STRUCTURAL STEEL AND EXPOSED STEEL PIPE.

SURFACE PREPARATION: SSPC-SP10 NEAR WHITE BLAST-IMMERSION SERVICE

TNEMEC

FIRST COAT: SERIES 94H-20 TNEME-ZINC 2.5-3.5 MILS DRY

SECOND COAT: SERIES 66HS HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

THIRD COAT: SERIES 66HS HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

* MINIMUM TOTAL DRY FILM THICKNESS 10.5 MILS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN THE NUMBER OF COATS SHOWN, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. KOPPERS,
    b. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 142

TYPE: EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR COPPER PIPING.

SURFACE PREPARATION: SSPC-SP1 SOLVENT CLEANING

TNEMEC

FIRST COAT: SERIES 66HS HI-BUILD EPOXOLINE 2.0-3.0 MILS DRY

SECOND COAT: SERIES 73U ENDURA-SHIELD 2.0-3.0 MILS DRY

* MINIMUM TOTAL DRY FILM THICKNESS 5.0 MILS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN THE NUMBER OF COATS SHOWN, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

   a. KOPPERS,
   b. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 150

TYPE: ACRYLIC LATEX

USE: ALL PVC SURFACES TO BE PAINTED, AS SPECIFIED OR SHOWN ON DRAWINGS.

SURFACE PREPARATION: CLEAN AND DRY.

GLIDDEN

FIRST COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

SECOND COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 4.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. BENJAMIN MOORE COMPANY,
    b. DEVOE AND REYNOLDS COMPANY, INC.,
    c. PRATT AND LAMBERT, INC.,
    d. PPG INDUSTRIES, INC.,
    e. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 161

TYPE: EPOXY

USE: SUBMERGED STEEL OF CIRCULAR THICKENING EQUIPMENT

SURFACE PREPARATION: SSPC-SP10 / NACE 2

TNEMEC

PRIMER:	SERIES 66HS HI-BUILD-EPOXYLINE – ONE COAT, MIN. 4.0 DRY MILS
INTERMEDIATE COAT:	SERIES 66HS HI-BUILD EPOXOLINE – ONE COAT, MIN 8.0 TO 15.0 DRY MILS
FINISH COAT:	SERIES 66HS HI-BUILD EPOXOLINE - ONE COAT, MIN 8.0 TO 15.0 DRY MILS

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. KOPPERS,
    b. SHERWIN-WILLIAMS COMPANY.

MATERIAL SCHEDULE 162

TYPE: EPOXY

USE: NON-SUBMERGED STEEL AND FERROUS MATERIALS OF CIRCULAR THICKENING EQUIPMENT

SURFACE PREPARATION: SSPC-SP6 / NACE 3

TNEMEC

PRIMER: SERIES 66HS HI-BUILD-EPOXYLINE – ONE COAT, MIN. 4.0 TO 6.0 DRY MILS

INTERMEDIATE COAT (LOW TEMPERATURE CURING CONDITIONS): SERIES 161HS TNEME FASCURE – ONE COAT, MIN 6.0 DRY MILS

INTERMEDIATE COAT (WARM TEMPERATURE CURING CONDITIONS): SERIES 66HS – ONE COAT, MIN 6.0 DRY MILS

FINISH COAT: SERIES 72 ENDURA-SHIELD- TWO COATS, MIN 2.0 TO 3.0 DRY MILS

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. KOPPERS,
    b. CARBOLINE.

+++ END OF SECTION +++

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DIVISION 10

SPECIALTIES

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SECTION 10200
LOUVERS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all louvers complete. 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. Work specified in this section is subject to the provisions of Section 15050, Basic Mechanical Materials and Methods.

C. Related Work Specified Elsewhere:

Section 15050, Basic Mechanical Materials and Methods.
Section 15910, Ductwork and Accessories.
Section 15990, Testing, Adjusting and Balancing of HVAC Systems.

1.2 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:

B. Product data: Indicate material types, finishes, sizes, fabrication, and installation details. Include free area chart/table, static pressure loss, air leakage, and water penetration data. Provide an submit catalog information on louver motor operators and a color and finish chart.

C. All louver performance data submitted for approval shall bear the AMCA Certified Ratings Seal for Air Performance and Water Penetration.

1.3 PROJECT CONDITIONS

A. Protection: Protect prefinished surfaces from damage and staining. Provide protective covering for louvers during subsequent construction.

B. Coordinate installation of louvers to be built into building structure. Secure templates and lay out to rough dimensions furnished by manufacturer.

PART 2 - PRODUCTS

2.1 LOUVERS

A. Acceptable Manufacturers:

1. Ruskin Model ELC6375DAX (Basis of Design);
2. American Warming and Ventilating;
3. Greenheck;
4. Or equal.

B. Characteristics: Louver components (heads, jambs, sills, blades, etc.) shall be factory assembled by the manufacturer into a complete unit. Louver sizes too large for shipping shall be built up by the Contractor from factory assembled louver sections to provide the overall sizes required.

C. Material: 6063-TS extruded aluminum alloy, meeting ASTM B221-79a, blades a minimum of 0.10-inch thick and frames a minimum of 0.120-inch thick. Frame depth shall be 6 inches. Provide extended sill on frame.

D. Finish: KYNAR 500 with 20-year warranty for corrosion protection.

E. Construction: Welded.

F. Blade Design: Stormproof with fixed double drainable blades. Operating blades not visible when open and drain to exterior. Nylon bearings, replaceable vinyl edge gaskets, and sponge neoprene or compressible, aluminum jamb gaskets.

G. Fasteners: Stainless steel.

H. Building Paper: 15-pound asphalt saturated organic felts meeting ASTM D266-77.

I. Security Screen: Furnish 1-inch wide extruded aluminum 6063TS alloy. U-shaped flange minimum 0.120-inch thick around front (exterior) face of louver. U-shaped flange shall be same size as louver. Furnish 18-16 mesh (Type 304) stainless steel one-piece security screen to cover face of louver and to extend a minimum of 7/8-inch into U-shaped flange all-around. Security screen shall be secured into U-shape flange at factory by compression fit. Secure U-shaped flange to louver with stainless steel (nonremovable) security screws, minimum 3/16-inch diameter. Provide security screws at each corner of flange and at maximum 12-inch intervals around face of flange. Refer to Section 15890, DUCTWORK AND ACCESSORIES.

J. Louvers shall conform with the following performance requirements:

Free Area: Not less than 44 percent for a 48-inch x 48-inch size.
Static Pressure Loss: Not more than 0.20-inch of water gauge at any airflow of 1000 fpm free area velocity in intake direction.
Water Penetration: Not more than 0.05 ounces per square feet of free area at an airflow of 1,040 fpm free area velocity.

K. Louver design shall incorporate structural supports as required to withstand a wind load of 20 pounds per square foot.

L. Furnish combination louvers with totally enclosed electric motor actuators suitable for a corrosive environment. Actuators shall be two-position, spring return, operator opening time not to exceed 60 seconds, sized to meet louver torque requirements.

M. Insect Screens: 10 mesh aluminum wire mounted in aluminum frames. Louver design shall allow screens to be removable and mounted on the face of louvers without interfering with louver, damper, and drive function.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Check openings to ensure that dimensions conform to Drawings.

B. Assure that openings are free of irregularities that would interfere with installation.

3.2 INSTALLATION

A. Install louvers in accordance with manufacturer's product data in prepared openings, plumb and level.

B. Attach louvers using stainless steel fasteners spaced at 1 foot 0 inch OC at head, sill, and jambs. Separate aluminum from dissimilar metals using one layer of building paper or as specified in Section 09900, Painting.

C. Louvers shall be caulked and sealed at the frame and flanges to make the installation watertight.

D. Combination louver dampers shall be installed with required damper operators and linkage mechanisms and shall be field adjusted for full opening/closure stroke. Louvers shall be interlocked with exhaust fans as scheduled on the Drawings and as described in Section 15950, HVAC Controls, of these Specifications.

3.3 ADJUSTING AND CLEANING

A. Set adjustable louver blades for uniform alignment in OPEN and CLOSED positions.

B. Adjust louvers so moving parts operate smoothly.

C. Repair damage to louvers to match original, or replace.

3.4 SCHEDULE

The Louver Schedule is contained in the Drawings.

+++ END OF SECTION +++

SECTION 10440

SIGNS & IDENTIFYING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Contractor shall furnish all the materials for and shall properly erect and install all identifying devices at the locations shown and as indicated on the Drawings, and as specified herein.

B. This shall include all identification signs and warning signs, including supports, fastening devices, and accessories, and all labor, materials, tools, and appurtenances required to complete the Work.

C. It is the intent of this Specification that the installation shall be complete in all respects and ready for use. The Contractor shall be responsible for all incidental details and for any special construction necessary to complete the work in an acceptable manner.

D. Related Work Specified Elsewhere:
1. Section 15060, Piping and Appurtenances.

1.2 SUBMITTALS:

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

B. Samples: Submit samples of each sign form and materials showing finished, colors, surface textures and qualities of manufacturer and design of each sign component including graphics.

1.3 QUALITY ASSURANCE:

A. Uniformity of manufacturer: For each sign form and graphic image process indicated furnish products of single manufacturer.

B. Quality of signage shall be not less than ASI-SPE construction.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Identifying devices shall be of the type and materials specified for each category. Unless otherwise indicated, signs shall be the manufacturer's stock items.

B. Life Safety Signs: Signs shall be butyrate with red lettering on white background, and conforming to OSHA regulations.
   1. FIRE EXTINGUISHER: Located above all extinguishers.
   2. DANGER - DO NOT DRINK THIS WATER: Located at each non - potable water station.
   3. DANGER - CONFINED SPACE ENTRY- ENTER BY PERMIT ONLY: Mounted near all confined spaces. (White background, red and black letters, 14" x 20").
   4. CAUTION – SLIPPERY SURFACE – located near all Polymer System areas
   5. LOW CLEARANCE – located at any low overhead conditions/pipes/obstructions.
   6. WARNING-BIOHAZARD – located within Sludge Dewatering and Sludge Pump Building
   7. DANGER – HIGH VOLTAGE – at each location as required for equipment specified in Division 16.
   8. WARNING – EYE AND EAR PROTECTION – within Sludge Dewatering Building and Sludge Pump Building.

C. Interior and Directional Signs: Signs shall be ASI/2 type A, constructed of 0.015-inch vinyl laminated to 1/4-inch acrylic backing. Letters shall ASI/2 pressure-sensitive vinyl letters. Signs shall have 1-inch border around perimeter.
   1. Emergency Shower, Eye Bath: Mounted to each station (Green background, white letters 9" x 20").
   2. Room Names – adjacent to each room in the Sludge Dewatering Building.

D. Exterior Signs:
   1. Products and Manufacturers: Provide one of the following:
      a. Graphic Blast Wall Mounted Signs, by Best Manufacturing Sign Systems, Inc.
      b. Blast Etched Fiberglass Exterior Signs by Visigraph Corporation
      c. Or equal
   2. Material: Provide surface-etched lettering and pictograms, sandblasted on an opaque three-ply laminate of 1/4-inch thick flat three-ply glass-reinforced resin sheet with non-glare surface and contrasting color core suitable for continuous operating temperatures of 190 degrees F.
   3. Alphabet and Graphics: Provide four-inch high Helvetica Medium alphabet; upper case letters and matching arrow type face.
   4. Provide opaque black letters on opaque white background with concealed, flush-mounted fasteners at each corner. Provide one sign for each building or structure name and one sign for each building or structure number. Sign size shall to be determined based on length of building/structure name and in no case shall

sign be less than 15 inches by 15 inches with 1/8-inch radiused corners.

5. Building Names – Sludge Dewatering Building, Solids Processing Pump Station.
6. Tank Names – Sludge Holding Tank.
7. Building Numbers – Building No. 81 for Sludge Holding Tank, Building No. 82 for Solids Processing Pump Station and Building No. 83 for Sludge Dewatering Building.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Locate sign units and accessories where shown or directed, using mounting methods of the type described and in compliance with the manufacturer's instructions.

B. Install signs level, plumb and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

3.2 CLEANING AND PROTECTION:

At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Engineer.

END OF SECTION

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SECTION 10520

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all wall mounted fire extinguishers. 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:

Section 10440, Identifying Devices.

1.2 SUBMITTALS

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

A. Manufacturer's certification.

B. Manufacturer's data and installation instructions.

1.3 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:

A. NEC, National Electric Code.

B. NEMA, Standards of National Electrical Manufacturers Association.

C. OSHA, Occupational Safety and Health Act.

D. NFPA, National Fire Protection Association.

1.4 QUALITY STANDARDS

A. The fire extinguishers 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, in accordance with NFPA10, and is a suitable application for these service conditions.

C. Manufacturer's offering products that comply with these specifications include:
1. Larsen's Manufacturing Company
2. J. L. Industries, Inc.
3. Modern Metal Products by Muckle
4. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 FIRE EXTINGUISHERS

A. Extinguishers:
1. Multi-Purpose Dry Chemical Fire Extinguisher.
Ten-pound capacity, enameled steel container with pressure-indicating gauge, for Class A, Class B, and Class C fires, UL rating 4A-60 B:C.
2. Carbon Dioxide Fire Extinguishers.
Ten-pound enameled steel container capacity, for Class B and Class C fires, UL rating 10 B:C.
3. Provide extinguishers complete with nozzle and pressure gauge.
4. Provide manufacturer's standard bracket supporting extinguisher at top and bottom, holding extinguisher off finished wall surface.

B. Unit shall be UL labelled. Unit shall have pressure indicating gauge rated for Class C fires.

C. Service, charge and tag each fire extinguisher not more than ninety-five (95) calendar days prior to the Date of Substantial Completion of the Work as that Date is established by the Engineer.

D. A universal emergency sign shall be attached to building structure above each fire extinguisher.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Bracket Mounted Extinguishers:
   1. Install 5'-6" above finish floor to extinguisher top.
   2. Install extinguishers just prior to Date of Substantial Completion, properly charged.

B. Prefinished Surfaces: Protect from damage or staining. Clean surfaces just prior to Date of Substantial Completion in accordance with manufacturer's recommendations and repair any damage to adjacent surfaces.

C. Leave items ready to receive final finish specified in other sections.

D. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

E. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Engineer.

3.3 SCHEDULE

A. Provide one dry chemical extinguisher inside doors 101 & 104.

B. Provide one carbon dioxide extinguisher inside doors 103 & 106.

+++ END OF SECTION +++

DIVISION 11

EQUIPMENT

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SECTION 11000

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 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 City's Engineer and Contractor and are not complete listings of all equipment, devices and material to be provided under this contract. The Contractor agrees to prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.2 QUALITY ASSURANCE

A. Arrangement: The arrangement of equipment shown on the Drawings is based upon information available to the City at the time of design and is not intended to show exact dimensions peculiar to a specific manufacturer. The Drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual equipment installation requirements. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment provided. No additional payment will be made for such revisions and alterations.

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.

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, 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:

$$e = \frac{W}{16N}$$

WHERE:

E = IMBALANCE, OUNCE-INCHES, MAXIMUM

W = WEIGHT OF THE BALANCED ASSEMBLY, POUNDS MASS

N = MAXIMUM OPERATIONAL SPEED, RPM

WHERE SPECIFIED, BALANCING REPORTS, DEMONSTRATING COMPLIANCE WITH THIS REQUIREMENT, SHALL BE SUBMITTED AS PRODUCT DATA.

PART 2 - PRODUCTS

2.1 FLANGES AND PIPE THREADS

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, stainless steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

2.2 BEARINGS

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.

2.3 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.

2.4 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: Unless otherwise specified, the following shall be adhered to. 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. Unless otherwise specified, the section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.5 COUPLINGS

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.

2.6 GUARDS:

Exposed moving parts shall be provided with guards which meet the requirements of OSHA. Guards shall be fabricated of 14 gage stainless steel, 1/2-13-15 expanded metal screen to provide visual inspection of moving parts without removal of the guard, unless otherwise specified. Guards shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.7 CAUTION SIGNS

Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material, minimum 1/8 inch thick, rigid, suitable for post mounting.

Letters shall be white on a red background. The sign size and pattern shall be as shown on the Drawings. Signs shall be installed near guarded moving parts.

2.8 GAGE TAPS, TEST PLUGS AND GAGES

Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Divisions 13 and 15, respectively.

2.9 NAMEPLATES

Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless steel screws or drive pins.

2.10 LUBRICANTS

The Contractor shall provide for each item of mechanical equipment a supply of the lubricant required for the commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the City's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the City with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.11 ANCHOR BOLTS

Anchor bolts shall be designed for lateral forces for both pullout and shear in accordance with the table below. Unless otherwise stated in the detailed specification, anchor bolt materials shall be 316 stainless steel.

SINGLE ANCHOR ALLOWABLE LOADS ON ANCHOR BOLTS [1]

Bolt Diameter (inch)	F1554 Grade 36 F593 Type 316, Condition A				F1554 Grade 55			
	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3,4] (lb)	Tension[3] (lb)	Minimum Embedment (inch)	Minimum Edge Distance and Spacing[2] (inch)	Shear[3] (lb)	Tension[3] (lb)
1/2	6	9	1,262	2,420	8.5	12.75	1,660	3,190
5/8	7.5	11.25	2,010	3,860	10.5	15.75	2,640	5,080
3/4	9	13.5	2,974	5,720	13	19.5	3,910	7,520
7/8	10.5	15.75	4,106	7,890	15	22.5	5,400	10,390
1	12	18	5,386	10,360	17	25.5	7,090	13,450
1 1/8	13.5	20.25	6,787	13,052	19	28.5	8,930	16,580
1 1/4	15	22.5	8,617	16,572	21	31.5	11,340	20,040

2.12 SPARE PARTS

Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high, or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts." A neatly typed inventory of spare parts shall be taped to the underside of the cover.

PART 3 - EXECUTION

Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 11002

RIGID EQUIPMENT MOUNTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. This section specifies minimum requirements for rigid equipment mounts (baseplates, soleplates, and mounting blocks) and their installation on equipment pads. Completed equipment supports shall consist of equipment pads, equipment anchors, and rigid equipment mounts (baseplates, soleplates, or mounting blocks) set in grout.
2. Unless alternate requirements for equipment mounts are specified in the applicable equipment specification, the requirements of this section shall be applied to rigid mounts for all rotating or reciprocating equipment that is used to mix, convey, or pressurize fluids (gases and liquids). The requirements of this section shall also apply whenever referenced in specifications for other types of equipment. If conflict exists between this section and requirements of individual equipment manufacturers, the more restrictive requirements shall prevail.

B. Definitions: Specific equipment mounting terminology used in this section conforms to the following definitions:

1. Baseplate: Fabricated (welded structural steel elements), cast, or plate steel base providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.
2. Soleplate: A machined plate, spanning an opening in the floor or equipment pad, providing a common mounting element on which the legs, feet, or mounting surfaces of equipment are mounted by means of bolted connections.
3. Mounting Blocks: Multiple smaller baseplates on which individual legs, feet or equipment supports are mounted when equipment or drivers are not fastened to a common baseplate or sole plate.
4. Equipment Pad: Concrete foundation (block or slab) supporting and elevating equipment mounts above the supporting structural floor slab or local grade.
5. Mounting Pads: Thickened or raised areas of baseplates and soleplates where the feet or mounting surfaces of mounted equipment and drivers are bolted and/or doweled to the baseplate or soleplate.
6. Leveling Blocks: Temporary steel blocks placed under baseplates, soleplates, or a mounting block at leveling positions (at equipment

anchors) for the purpose of leveling baseplates, soleplates, or mounting blocks prior to grouting.

7. Shims: Thin stainless steel plates of a uniform thickness installed on top of Leveling Blocks for fine adjustment of level. Shims may also be used between equipment or drivers and baseplates, soleplates, or mounting blocks for equipment alignment purposes.
8. Wedges: Pairs of uniformly tapered metal blocks that are stacked with the tapered surfaces reversed (relative to the other wedge) so that the top and bottom surfaces of the wedges are parallel. Wedges are used between equipment pads and baseplates, soleplates, or mounting blocks for the purpose of leveling baseplates, soleplates, or mounting blocks.
9. Mounting Stud: Threaded rod or bolts anchored to baseplates, soleplates, or mounting blocks for the purpose of mounting equipment or ancillary devices onto baseplates, soleplates, or mounting blocks.
10. Reinforcement Dowels: Steel reinforcement rods embedded in concrete, across a cold joint, for the purpose of transferring loads or force across the joint.
11. Machine Alignment Dowels: Tapered diameter rods inserted in tapered diameter holes for the purpose of aligning machinery. The practice of drilling tapered diameter holes through machinery and baseplates so that Machine Alignment Dowels may be inserted to facilitate alignment of machinery is known as Doweling.
12. Leveling Position: A location on the top of a concrete equipment pad where leveling tools and equipment will be temporarily installed or used for the purpose of leveling baseplates, soleplates, and mounting blocks prior to grouting.
13. Grout Manufacturer: Refers to the manufacturer of the epoxy grout system used for installation of rigid equipment mounts.
14. Grout Manufacturer's Technical Representative(s): Refers to the technical representative(s) of the Grout Manufacturer.

C. Equipment Mounting Requirements: Unless otherwise specified, equipment and drivers shall be rigidly mounted on a common cast iron or fabricated steel baseplate or soleplate grouted into place on a concrete equipment pad. Under no circumstances shall baseplates, soleplates, or mounting blocks be grouted directly to concrete slabs or floors. Equipment that uses an interdependent equipment and driver mounting configuration (equipment that is bolted onto the driver frame and equipment that supports the driver entirely from the equipment frame) may be bolted directly on concrete or grout surfaces of equipment pads if the driver is less than five horsepower. Bolting equipment directly on concrete or grout surfaces of equipment pads is not acceptable for equipment and drivers that do not have an interdependent equipment and driver mounting configuration.

1.2 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. It is a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed document, the requirements of this section shall prevail.
2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI/HI 1.4	Centrifugal Pumps – Installation, Operation and Maintenance
ANSI/HI 2.4	Vertical Pumps – Installation, Operation and Maintenance
API RECOMMENDED PRACTICE 686	Recommended Practices for Machinery Installation and Installation Design
ASTM E329	Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
MIL-PRF-907E	Anti-Seize Thread Compound, High Temperature
SSPC	Society for Protective Coatings Specifications, Vol. 2
IBC	2001 International Building Code (including local amendments)

B. Quality Control by Contractor:

1. To demonstrate conformance with the specified requirements for rigid equipment mounts, the Contractor shall provide the services of an independent testing laboratory that complies with the requirements of ASTM E329. The testing laboratory shall sample and test equipment mount related materials as indicated in this Section. Costs of testing laboratory services shall be borne by the Contractor.
2. For equipment with drivers 20 horsepower and greater, the Contractor shall furnish the services of a grout manufacturer's technical representative that has been factory trained by the grout manufacturer. The grout manufacturer's technical representative shall perform training and quality control of epoxy grout installation for rigid equipment mounts as indicated in this section.

1.3 SUBMITTALS

The following information shall be provided in accordance with the submittal requirements specified in the General Conditions.

A. A copy of this specification section, with addendum updates included, (referenced sections need not be included for Section 11002) with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration. Copies of this specification section shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

B. Schedule of rigid equipment mount installations specified in paragraph 11002-2.1.

C. Name, employer and certificates or other information documenting compliance with the journeyman qualifications requirements for millwrights who will install rigid equipment mounts, as specified in paragraph 11002-3.3. C.

D. Certificates or other documentation issued by the epoxy grout manufacturer that demonstrates that the grout manufacturer's technical representative has been factory trained on installation of epoxy grout for equipment mounts, as specified in paragraph 11002-1.2 B. 2.

E. Shop drawings for all equipment pads, equipment anchors, and baseplate, soleplate or mounting block details. Shop drawings shall depict size and location of equipment pads and reinforcement; equipment drains; equipment anchor, size, location, and projection; expansion joint locations; elevation of top of grout and grout thickness; elevation of top of baseplate; soleplate; or mounting block; size and location of electrical conduits; and any other equipment mounting features embedded in equipment pads. Shop drawings for equipment pads, equipment anchors, and baseplate, soleplate, or mounting blocks shall be numbered and marked (specification number and equipment number) for inclusion (filing) with the associated equipment submittal requirements.

PART 2 - PRODUCTS

2.1 GENERAL

Prior to initiating any installation efforts, the Contractor shall produce a rigid equipment mount installation schedule containing the expected dates for installing equipment anchors and preparation of equipment pads for leveling, grouting, and final equipment anchor clamping for each item of equipment. The schedule shall list the equipment, by equipment tag number, and shall list applicable equipment specification section, motor horsepower, and name of the Contractor's representative responsible for quality control during installation of rigid equipment mounts. The schedule shall be accompanied by written verification of equipment anchor clamping torque from the manufacturer of each item of equipment to be installed with rigid equipment mounts.

2.2 CONCRETE EQUIPMENT PADS

A. Concrete equipment pads shall be as shown in the structural details for equipment pads and equipment anchors for rigid mounted equipment.

B. The Contractor shall submit equipment anchor calculations for all equipment with drivers 20 horsepower and greater. Equipment anchor calculations shall demonstrate that equipment anchor size, embedment, and edge distance comply with the UBC and local governing code and are sufficient to resist the maximum lateral and vertical forces specified in

paragraph 11000-2.11. Equipment anchor calculations shall be sealed by a registered structural or civil engineer licensed in the State of Georgia.

2.3 BASEPLATES, SOLEPLATES, AND MOUNTING BLOCKS

A. General:

1. Unless otherwise specified, Type I baseplates, soleplates, and mounting blocks shall be a minimum of 1 inch thick for equipment with drivers 20 horsepower and larger.
2. Type I baseplates, soleplates, and mounting blocks shall have edges of surfaces bearing on grout rounded to a radius of not less than 0.25 inch. Horizontal corners of Type I baseplates, soleplates, or mounting blocks shall be rounded to a radius of not less than two inches to avoid producing stress risers on the grouted foundation. Grout pouring holes (minimum 4 inches in diameter for epoxy grout, minimum 2 ½ inches in diameter for cementitious nonshrink grout) shall be provided in all baseplates and soleplates and all baseplates and soleplates shall have grout release holes. Mounting blocks may be grouted without grout pouring holes provided that no dimension of the mounting block (width or length) exceeds 18 inches. Grout relief or vent holes (minimum 1 inch in diameter) shall be provided in all baseplates, soleplates, and mounting blocks. Internal stiffeners shall be provided on all cast and fabricated baseplates and shall be designed to allow free flow of grout from one section of the baseplate to another. The minimum acceptable opening in cross bracing and stiffeners shall be 2 inches high by 6 inches in width. All welds shall be continuous and free from skips, blowholes, laps and pockets.
3. Mounting holes for equipment anchors shall be drilled through baseplates, soleplates, and mounting blocks. Mounting holes for equipment anchors shall not be burned out and they shall not be open slots. Unless otherwise specified, mounting studs shall be Type 316 stainless steel or as recommended by the equipment manufacturer for the specific service. An anti-seize or anti-galling compound, as specified in paragraph 11002-2.06, shall be applied to all mounting stud threads prior to installing nuts on mounting studs. Terminations requiring connections to baseplates, soleplates, or mounting blocks shall be acorn nuts welded to the under side of the baseplate or nuts welded to the underside of the baseplate and plugged with cork, plastic plugs or grease. In no case shall the fastener terminate only into the metal base. Where baseplates, soleplates, or mounting blocks are leveled using jackscrews, jackscrew threads shall be tapped in thickened pads or otherwise in sufficient metal to provide ease in adjusting level.
4. Mounting pads for equipment shall be machined after all welding and stress relieving and shall be coplanar within 0.002 inch per foot in all directions. Mounting pads shall extend not less than 0.5

inch beyond the perimeter of the foot or mounting surface of the mounted equipment, in any direction.

5. Equipment baseplates shall provide common support for the equipment and driver (and flywheel, if one is specified). Baseplates for equipment with drivers 20 horsepower and greater shall be furnished with eight transverse alignment (horizontal) positioning jackscrews for alignment of equipment drivers on horizontal surfaces of baseplates. Two of the eight transverse alignment/positioning jackscrews shall be installed in perpendicular directions in a horizontal plane at the mounting position for each corner or foot of the equipment driver. (Eight additional jackscrews shall be provided for transverse alignment of the flywheel, if flywheels are specified.)

B. Type I Baseplates: Type I baseplates shall be plate or fabricated structural steel baseplates with thickened steel mounting pads for doweling and bolting equipment to the baseplate. The baseplates shall be rectangular in shape for equipment other than centrifugal refrigeration machines and pump baseplates, which may be "T" or "L" shaped to accommodate the equipment drive and accessories. Baseplates for split case pumps shall include supports for suction and discharge elbows, if required by the specified configuration. Perimeter members shall be beams with a minimum depth equal to 1/10th of the longest dimension of the baseplate. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer.

C. Soleplates: Where soleplates are provided, the underside shall be scribed with the words “THIS SIDE DOWN” using welding rod material prior to milling the mounting pad for each equipment foot or mounting surface. Mounting surfaces and mounting pads on soleplates shall be milled flat to a tolerance of not less than 0.002 inch per foot in all directions. Soleplates shall be machined for an indexed fit to the mounted equipment or driver.

D. Mounting Blocks: Where equipment is fabricated or cast with feet or mounting surfaces that are not fastened to a common baseplate or soleplate, as in dry-pit bottom suction pumps, the equipment may be supported on individual concrete piers or equipment pads in lieu of a common baseplate or soleplate and equipment pad. In such instances, the equipment shall be supported at the feet or mounting surfaces on individual mounting blocks, which shall be leveled and grouted into place on the individual piers or equipment pads as specified in this section. Vertical volute-type pumps weighing more than 2,000 pounds shall be mounted on mounting blocks under each foot or mounting surface for the pump. All mounting blocks shall be furnished with jackscrew threads (three locations, minimum) tapped in the mounting block for the purpose of leveling mounting blocks with jackscrews.

2.4 GROUT FOR EQUIPMENT PADS

A. Epoxy Grout for Equipment Mounting: Unless otherwise specified, grout for setting bearing surfaces of baseplates, soleplates, and mounting blocks on equipment pads shall be Epoxy Grout for Equipment Mounting as specified in Section 03600. Where the term epoxy grout is used in the context of details and specifications for equipment mounting it shall mean Epoxy Grout for Equipment Mounting.

B. Cementitious Nonshrink Grout: Cementitious Nonshrink Grout, specified in Section 03600, may be used for setting bearing surfaces of baseplates, soleplates, or mounting blocks on equipment pads where equipment drivers are 20 horsepower and smaller and the combined weight of equipment and driver is less than 1000 pounds. Where the term nonshrink grout or cementitious grout is used in the context of details and specifications for equipment mounting it shall mean Cementitious Nonshrink Grout. Training and quality control by the grout manufacturer's technical representative is not required for rigid equipment mounts installed with cementitious non-shrink grout.

2.5 EPOXY PRIMER

Epoxy primer shall be a lead-free, chrome-free, rust-inhibitive, two-component epoxy primer specifically designed for use on metal substrates and in conjunction with epoxy grout. The epoxy primer shall be a product of the epoxy grout manufacturer.

2.6 ANTI-SEIZE/ANTI-GALLING COMPOUND

Anti-seize or anti-galling compound shall be a molybdenum disulfide and graphite combination in an aluminum complex base grease conforming to MIL-PRF-907E. Acceptable products include Jet Lube 550 by Jet Lube, Inc., E-Z Break by LA-CO, or equal.

2.7 PRODUCT DATA

The following information shall be provided in accordance with the product data requirements specified in the General Conditions:

A. Equipment anchor calculations specified in paragraph 11002-2.2.

B. Results of grout strength tests, as specified in paragraph 11002-3.3 D.

C. List of Contractor's equipment installation staff that has completed epoxy grout manufacturer's grout installation training specified in paragraph 11002-3.2 A.

PART 3 - EXECUTION

3.1 GENERAL

A. Grouting for installation of equipment on equipment pads shall take place prior to connecting any field piping or electrical and instrumentation systems. Unless the Engineer accepts an alternate installation procedure in writing, baseplates, soleplates, and mounting blocks shall be leveled and grouted with the equipment removed. Pumps shall be installed in accordance with this section and ANSI/HI 1.4 or ANSI/HI 2.4, as appropriate for the type of pumping equipment installed.

B. Connecting piping with flexible connections and/or expansion joints shall be anchored such that the intended uses of these joints are maintained in the piping system without imposing strain on the equipment connections.

C. Where an equipment manufacturer's installation requirements include a rigid connection between the machine and connecting piping systems, the Contractor shall delete any flexible coupling (including equipment connection fittings) shown on the drawings and install the equipment in the following manner, in lieu of installing the flexible coupling:
   1. The equipment pad shall be prepared as shown on the details for rigid equipment mounts
   2. The baseplate, soleplate, or mounting blocks supporting the equipment shall be installed, leveled, and grouted in place as specified in this section.
   3. The equipment shall be installed, aligned and doweled in place as specified in Section 11005.
   4. The piping shall be installed and aligned to the equipment connections and the field piping connections without welding one of the joints for one section of pipe between the equipment connection and the field piping and all valving. All flanged joints shall be bolted up and pressure tested.
   5. All piping shall be fully supported by supports designed to accept their full weight and thrust forces.
   6. The final sections of piping shall be aligned with the equipment and field connections without the use of jacks, chain falls or other devices to force it into alignment.
   7. The final piping joints shall be welded only after the previous steps have been completed and accepted by the Engineer.

3.2 EPOXY GROUT TRAINING AND QUALITY CONTROL

A. Epoxy Grout Training: Prior to commencing rigid equipment mount installation work on equipment pads, the Contractor shall furnish the services of a grout manufacturer's technical representative to conduct a training school for the workers that will be using the epoxy grout for rigid equipment mount installations. The school shall be not less than 4 hours in length and shall cover all aspects of using the products, from mixing to

application. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. The epoxy grout manufacturer shall furnish a list of school attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

B. Epoxy Grout Quality Control:

1. For equipment with drivers 20 horsepower and greater, the epoxy grout manufacturer's technical representative shall provide quality control services for epoxy grout installation in rigid equipment mounts. The epoxy grout manufacturer's technical representative shall be on site to inspect and verify that the application personnel have successfully performed surface preparation, epoxy grout application, and Quality Control Inspection in accordance with these specifications for a representative portion of the epoxy grout installation work.
2. Specifically, the epoxy grout manufacturer's technical representative shall perform the following services for at least one rigid equipment mount installation for each equipment type and size:
   a. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
   b. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria, including but not limited to substrate profile, degree of cleanliness, and moisture.
   c. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
   d. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
   e. Inspect preparation and application of epoxy grout form work for conformance to the specifications.
   f. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during installation.
   g. Inspect epoxy grout for cure.
   h. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
   i. Conduct a final review of completed epoxy grout installation for conformance to these specifications.

3.3 INSTALLATION

A. Concrete Equipment Pad Preparation:

1. After the concrete is fully cured, the top of the equipment pad shall be roughened by chipping the surface. Chipping shall remove all laitance and defective or weak concrete and result in a rough surface profile with a 0.25 inch minimum amplitude. Chipping shall expose broken aggregate without dislodging unbroken aggregate from the cement matrix and shall not cause fractures below the concrete surface. Leveling surfaces of the concrete that have been finished smooth and level for baseplate, soleplate, or mounting block leveling at equipment anchors shall be protected from damage during chipping. A light duty, hand held pneumatic chipper with a chisel type tool shall be used for chipping the equipment pad concrete surface. Abrasive blast, bush-hammer, jackhammers with sharp chisels, heavy chipping tools, or needle gun preparation of concrete surfaces to be grouted is not acceptable.
2. Prior to leveling activities, satisfactory removal of defective or weak concrete shall be demonstrated in the presence of the Engineer by operating the chipper on the chipped concrete surface at locations identified by the Engineer. The chipped surface of the concrete shall be such that the final baseplate, soleplate, or mounting block elevation results in the grout manufacturer's recommended grout thickness between the surface of the equipment pad and the lower baseplate flange, underside of the soleplate or underside of mounting block.
3. All dust, dirt, chips, oil, water, and any other contaminants shall be removed and the surface protected with plastic sheeting until grout is installed.
4. Concrete equipment pad surfaces that have been finished smooth and level for use as leveling positions shall be protected from damage during chipping activities. Alternatively, leveling positions may be restored on chipped surfaces. Leveling positions shall be restored by installing leveling blocks or leveling plates for jackscrews on a high compressive strength epoxy putty (Philadelphia Resins, Phillybond Blue 6A, or equal). Leveling blocks and leveling plates shall be installed level on the epoxy putty.

B. Baseplates, Soleplates, and Mounting Blocks: All surfaces of baseplates, soleplates, and mounting blocks to be in contact with epoxy grout shall be cleaned to SSPC SP-6 and shall be primed with epoxy primer within 8 hours of cleaning.

C. Leveling:
1. All machinery shall be mounted and leveled by journeyman millwrights. Precision surveying equipment shall be used for leveling. Machinists' spirit levels will not be permitted for leveling purposes for any baseplate, soleplate, or mounting block

with a plan dimension greater than 4 feet. Baseplates and mounting blocks shall be leveled to a maximum tolerance of 0.002 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. Soleplates shall be leveled to 0.0005 inch per foot or as otherwise required by the equipment manufacturer, if more stringent. An anti-seize or anti-galling compound specified in paragraph 11002-2.6 shall be applied to all equipment anchor threads prior to beginning baseplate, soleplate, or mounting block leveling.

2. All baseplates, soleplates, and mounting blocks shall be leveled against steel surfaces (jackscrew plates, leveling blocks, leveling nuts, support plates, or other steel surfaces). Use of other materials for leveling purposes is strictly and specifically prohibited. Unless otherwise specified, baseplates, mounting blocks, and soleplates shall be leveled as indicated in the leveling details. Leveling equipment and tools shall be stainless steel leveling blocks and shims, steel wedges, or jackscrews bearing on leveling plates. Leveling nuts may be used for leveling baseplates and soleplates weighing less than 200 pounds. The use of leveling nuts for leveling mounting blocks is not permitted.
3. After baseplates, soleplates, or mounting blocks have been leveled on the leveling equipment, the Contractor shall clamp the baseplates, soleplates, or mounting blocks in position by installing the equipment anchor nuts and washers. Clamping torque shall be less than the final clamping torque specified in paragraph 11002-2.1, but sufficient to hold the baseplate, soleplate, or mounting block in position. The Contractor shall verify that the correct level and position of the baseplate, soleplate, or mounting block has been maintained after clamping on the leveling equipment.
4. Leveling blocks shall be stainless steel, four inches square and 1-1/2 inches thick with an open-ended slot terminating in the center for the equipment anchor. Leveling blocks shall be machined flat on all horizontal surfaces and placed under the baseplate or soleplate at each equipment anchor. Shims shall be pre-cut stainless steel, slotted for removal after grouting, and shall extend not less than three inches beyond the baseplate, soleplate or mounting block. Leveling blocks and shims shall be coated with a light oil just prior to beginning the leveling and grouting work. Shims shall be placed so the tabs on the shims are easily accessible.

D. Grouting:

1. Grout forms shall be built of minimum 0.75 inch thick waterproof plywood and shall be securely braced (minimum brace size shall be two-by-four lumber). Forms shall be designed for a minimum of 6 inches hydrostatic head above the final elevation of the grout, to assist in flow during installation. Equipment mounting grout

shall be furnished with expansion joints installed at four to six foot intervals, perpendicular to the centerline of baseplates.

2. Forms shall be coated with three coats of paste wax on all areas that will come in contact with the grout to prevent the grout from bonding to the forms. Forms shall be waxed before assembly to prevent accidental application of wax to surfaces where the grout is to bond. Before any forms are installed, all concrete surfaces that will contact epoxy grout shall be free from any foreign material, such as oil, sand, water, wax, grease, etc. Forms shall be liquid tight. Any open spaces or cracks in forms, or at the joint between forms and the foundation, shall be sealed off, using sealant, putty, or caulking compound. All outside vertical and horizontal edges of the grout shall have 45-degree chamfers as indicated in the equipment anchor details for rigid equipment mounts. Match chamfers in concrete portions of the equipment pad. Block outs shall be provided at all shimming and leveling positions to allow removal of leveling equipment and tools after the grout has cured. Jackscrews shall be coated with a light oil or other acceptable bond-breaking compound prior to grouting.
3. The 45-degree perimeter chamfer strip shall be located at the final elevation of the grout. The final elevation of the grout on baseplates with exposed I-beam or C-channel supports shall be at the top of the lower support flange. The top of the grout, on all other baseplates soleplates, and mounting blocks, shall be at least 1.0 inch above the bottom or underside of the baseplate, soleplate, or mounting block and shall not be higher than the top of the baseplate, soleplate, or mounting block. The grout's final elevation shall not be so high as to bond the equipment anchor nut and washer.
4. The resin and hardener for epoxy grout for equipment mounting shall be mixed in accordance with the epoxy grout manufacturer's recommendations. Epoxy grout shall be placed at the center of one end of the baseplate or soleplate and worked toward the ends in such a manner as to force the air out from beneath the baseplate or soleplate and out the vent holes, to eliminate voids. Epoxy grout shall be placed in a manner that avoids air entrapment, using a head box to pour grout into the grout holes. When the head box is moved to the next grout hole, a 6 inch high standpipe shall be placed over the grout hole and filled with grout. Use of vibrating tools and/or jarring (rapping or tapping) forms to facilitate grout flow is not permitted during placement of epoxy grout.
5. The Contractor shall exercise care to never allow the grout to fall below the baseplate level once the grout has made contact with the baseplate. Grout placement shall be continuous until all portions of the space beneath the baseplate, soleplate, or mounting block have been filled. Subsequent batches of grout shall be prepared so

as to be ready when the preceding batch has been placed. Under no circumstances shall the grouting operation be halted because of lack of grout mix. After the entire baseplate is full, 6 inch high standpipes shall be maintained over each grout hole, to continue purging of air. When the grout has started to take an initial set (typically this is determined by a noticeable increase in temperature and no flow of grout at the vent holes) the standpipes shall be removed and excess grout cleaned from all surfaces.

6. Where the cavity under a baseplate or mounting block extends above the elevation of the top of the bolting flange for the baseplate or mounting block, grouting may be completed in two pours. Under these circumstances, the first grout pour shall be continuous until the lower face of the bolting flange for the baseplate or mounting block is submerged in grout a minimum of one inch. The second grout pour shall be completed with standpipes and air purges as specified in the previous paragraph.
7. Grout forms shall be checked for leaks throughout grout pours. Leaks shall be repaired immediately to prevent formation of voids. A final check of baseplate, soleplate, or mounting block level and elevation shall be performed before the grout sets.
8. A grout sample shall be taken for each equipment pad that has a baseplate, soleplate, or mounting block set in grout. The sample shall be placed in a cylinder of sufficient size to yield three two-inch cubes as test samples. The samples shall be tagged with project name, date, time, the equipment number and ambient temperature at the time of placement. Once the epoxy grout cylinder has been completely filled, it shall be placed next to the foundation of the equipment being grouted and allowed to cure for 48 hours. After 48 hours, the test cylinder shall be tested in accordance with the grout manufacturer's recommendations by the independent testing laboratory specified in paragraph 11002-1.2 B. The results shall be reported directly to the Engineer. Forms shall be removed only after the grout has cured sufficiently and upon specific permission from the Engineer.

E. Completion:

1. Upon acceptance by the Engineer and the equipment manufacturer's representative and after the grout has reached sufficient strength, grout forms and block outs at leveling positions shall be removed. Leveling blocks and shims or wedges and support plates shall be removed, leveling nuts and jack screws shall be backed off to allow the grout to fully support the baseplate, mounting block, or soleplate. Take care not to damage the grout during removal of extended shimming material or leveling equipment and tools.

2. The equipment anchor nuts shall be tightened, using calibrated indicating torque wrenches, to develop the full clamping force required by the equipment manufacturer.
3. Equipment anchor nuts shall be tightened in increments of not more than 25 percent of the final torque value in an alternating pattern to avoid stress concentration on the grout surface. After tightening equipment anchor nuts to final values, apply additional wax, grease, or mastic to all exposed portions of the equipment anchor beneath the baseplate, soleplate, or mounting block.
4. After applying additional wax or mastic to exposed portions of equipment anchors, block outs (pockets) for access to leveling nuts, leveling blocks and shims, or wedges shall be filled with the grout material installed under baseplates, soleplates, or mounting blocks and pointed after the equipment anchor nuts have been tightened to final values. Jackscrews shall be removed and holes in the baseplate, soleplate, or mounting blocks filled with a flexible sealant (silicone rubber) or a short cap screw.
5. Check for baseplate, soleplate, or mounting block movement (soft foot) by individually loosening and re-tightening each equipment anchor. Vertical movement at each equipment anchor shall be measured and recorded during loosening and retightening and shall not exceed 20 micrometers (0.001 inch). Vertical movement shall be measured using a magnetic-based dial indicator on the baseplate, soleplate, or mounting block referenced to the epoxy grout surface of the equipment pad or other approved method. Soft foot conditions shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks.
6. Check for grout voids by tapping along the upper surfaces of the baseplate, soleplate, or mounting block. Grout voids shall be sufficient cause for removal and reinstallation of grout and baseplates, soleplates, or mounting blocks. Grout voids shall be marked. At the discretion of the Engineer, grout voids may be repaired as specified in Chapter 5, Section 3.16 of API 686.

3.4 FINAL INSPECTION

The Engineer will conduct a final inspection with the Contractor for conformance to requirements of the contract documents.

END OF SECTION

SECTION 11005
MACHINE ALIGNMENT

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies requirements for alignment of directly coupled mechanical equipment weighing 1000 pounds or more and/or greater than 100 horsepower furnished or modified under this contract. Equipment direct coupled to the motor with drivers 100 horsepower and less and belt or chain driven machinery are specifically exempted from the requirements of this section.

1.2 QUALITY ASSURANCE

A. General: All equipment shall be aligned using laser alignment equipment to the tolerances specified by the subject equipment manufacturer or the criteria specified in this section, whichever is more stringent.

B. Alignment Criteria: Unless otherwise specified by more stringent manufacturers' requirements, all mechanical equipment affected by this section shall be aligned to the following criteria:

Maximum Tolerable Misalignment

Speed, rpm, maximum	Short Couplings (Distance between flex planes ≤ 4")		Spacer Shafts angle at each flex plane in mils/inch or projected offset in mils/inch of spacer length
	Offset (mils)	Angularity (mils/inch)	
600 and less	5.0	1.0	1.8
900	3.0	0.7	1.2
1,200	2.5	0.5	0.9
1,800	2.0	0.3	0.6
3,600	1.0	0.2	0.3
7,200	0.5	0.1	0.15

Notes: (1) Soft foot (machine frame distortion) shall be not more than 2.0 mils for any speed.

(2) Separately mounted equipment connected by offset universal joints are exempted from the offset and angularity requirements, but all units must be installed and leveled as specified in this section.

C. Alignment Equipment: Alignment equipment used to perform the work required under this section shall employ laser alignment techniques to achieve the required tolerances. The equipment shall be computer based and its software shall be compatible with current Windows® based spreadsheets and databases. The equipment shall employ a hand-held

field computer using a graphic interface to determine actual alignment and necessary corrective action to bring equipment into required tolerance. The link between field measurement components and the computer shall be through cable, infrared, or wireless transmission.

1.3 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
Shaft Alignment Handbook	Shaft Alignment Handbook, Third edition, John Piotrowski, Marcel Dekker Inc.

PART 2 - PRODUCTS

2.1 EQUIPMENT

Laser alignment equipment shall be Rotalign® Ultra as distributed by Ludeca, Inc., of Doral, Florida, or equal.

2.2 ITEMS TO BE FURNISHED TO OWNER:

The following shall be furnished to the Owner upon completion of all alignment work for the project or appropriate portion thereof and prior to substantial completion of the project or portion thereof:

All alignment records, in both hard copy and in computer memory. The hard copy shall be signed and dated by the technician performing the alignment work and shall be witnessed by the Engineer.

PART 3--EXECUTION

3.1 GENERAL

A. After machine base grouting as specified under Section 11002, all machines mounted on base plates or soleplates specified above shall be aligned as specified under this section.

B. Alignment work shall be performed by journeyman millwrights skilled in this type of work under the supervision of a technician trained in the use of the laser alignment by the manufacturer or vendor of the alignment equipment. The use of untrained laborers, carpenters or apprentices for this work will not be acceptable.

3.2 PROCEDURE

A. Sequence: Machines supported on integral feet or support pads shall be leveled, grouted and aligned in the following order: driven machine; intermediate bearings or machines; and driver. Under certain circumstances, such as a diesel engine driving a generator, it may be preferable to reverse this order and set the driver first. The Contractor shall submit a written request for a reversal of the alignment order to the Engineer and the Engineer must approve any change in alignment order in writing before it will be allowed.

B. Alignment: All machines shall be rough aligned without any connections to piping, electrical and instrumentation systems. Upon completion of all field connections, alignment shall be rechecked to demonstrate no change. If change has occurred, the Contractor shall eliminate any external forces affecting machine alignment.

C. Next, soft foot (machine frame distortion) shall be measured and brought to within the permissible tolerances (see paragraph 1.02 B, Note 1). Thereafter, the alignment shall be rechecked and the alignment process repeated if necessary to bring all machinery to final alignment tolerances.

3.3 VERIFICATION

A. Factory Personnel: Where required by other sections in this project manual, factory authorized installation technicians representing the equipment manufacturer shall witness final alignment work. After completion of all alignment work, acceptance of the work shall be documented in writing by factory installation technicians.

B. Verification: All alignment work shall be independently checked using the shaft and coupling spool method described in the Shaft Alignment Handbook. All final results of the alignment work shall be subject to inspection and verification by the Engineer.

END OF SECTION

SECTION 11020

VIBRATION AND CRITICAL SPEED LIMITATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies vibration and critical speed limitations for rotating mechanical equipment. Factory and/or field testing and vibration measurements shall be taken when specified in the individual equipment specification sections.

1.2 VIBRATION LIMITATIONS

A. General: Vibration frequencies shall span the range from 5.0 to 5000 Hz. Where specified, measurements shall be obtained while the installed equipment is operating within the specified speed range.

B. Centrifugal:

1. Machines With Sleeve Bearings: Unless otherwise specified, centrifugal machines with sleeve bearing shafts shall not exhibit unfiltered RMS readings for vibration displacement in excess of the following:

Shaft speed range, rpm	Displacement, peak to peak, mils
Up to 900	3.5
901-1800	3.0
1801-3000	2.5
3001-4500	2.0
Above 4500	1.6

2. Displacement measurements shall be taken radially on the shaft at two points at each bearing, except for well pumps which shall be measured at top of motor. Measuring points shall be 90 degrees apart.

3. Machines With Antifriction Bearings: Unless otherwise specified, centrifugal machines with antifriction bearing shafts shall not exhibit unfiltered RMS readings for vibration velocity in excess of 0.12 inch per second. Velocity measurements shall be taken on one point of each bearing housing.

C. Positive Displacement Machines:
Unless otherwise specified, positive displacement machines of the rotary, reciprocating and controlled volume types shall operate without any lateral or torsional vibration characteristics that may accelerate wear of the equipment. The Contractor shall provide manufacturer's certification that the manufacturer has inspected the machine under operating conditions and found it to comply with the requirements of this paragraph.

1.3 CRITICAL SPEED REQUIREMENTS

Unless otherwise specified, rotating mechanical equipment shall not exhibit critical speeds within the specified range of operating speeds. Critical speeds for equipment with rigid rotor systems shall be at least 20 percent greater than maximum operating speed. Critical speeds for equipment with flexible shaft rotor systems shall be at least 15 percent below minimum operating speed and 20 percent above maximum operating speed.

PART 2 - PRODUCTS

2.1 PRODUCT DATA

Manufacturer's certified data showing location of critical speeds in relation to operating speeds shall be provided as product data in accordance with the General Conditions.

END OF SECTION

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SECTION 11021
VIBRATION ISOLATION SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope: This section specifies vibration isolation system requirements for mechanical equipment. Additional vibration isolation system requirements are provided in individual mechanical equipment specification sections. Mountings which are rigidly anchored to the supporting floor system are specified in Section 11002.

B. Mounting Requirements: Unless the equipment incorporates unit construction using an integral rigid frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. Cast iron bases are not permitted when equipment is furnished with a vibration isolation system. Where specified, the equipment, including the base, shall be mounted on or suspended from vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the supporting structure. Vibration isolation available internally in the equipment will not be considered equivalent and shall not be provided when vibration isolation as specified herein is required. Normally provided internal vibration isolators shall be replaced with rigid supports in such cases. Vibration isolators shall be selected in accordance with unit weight distribution to produce reasonably uniform deflections at each support. Unless otherwise specified, bases, isolators, and deflections shall be as specified in Table 27, ASHRAE CH-52.

C. Design Requirements:

1. The Contractor shall cause all vibration isolation systems, including the isolators, seismic restraints and flexible connectors between the isolated equipment and associated piping, ducting and/or electrical work, to be designed by a professional engineer qualified in this type of work. This provision, however, shall not be construed as relieving the Contractor of his overall responsibility for the work. The Contractor shall submit a copy of the engineer's calculations for design of the vibration isolation systems, stamped with the engineer's seal. Flexible connectors shall be provided by the manufacturer of the mechanical equipment item in accordance with the recommendations of the vibration isolation system design engineer. Contractor shall provide all piping and ancillary devices shown, specified and required to provide a fully functional system.

D. Contractor Design of Vibration Isolation Systems:

In addition to materials, labor, and plant required to construct piping systems, Contractor shall provide professional engineering services (“Design Professional”) for the design and inspection of piping systems work.

E. Seismic Restraints:

1. General: Restraint devices shall resist the forces specified and shall be designed in accordance with the IBC for seismic design category C, site class D. Design lateral forces shall be distributed in proportion to the mass distribution of the equipment.

2. Floor Mounted Equipment: Equipment and appurtenances resiliently floor mounted on spring or pad type vibration isolators, except for curb mounted equipment, shall be provided with seismic snubbers. Equipment shall receive four all-directional restraint/snubbers. The capacity of snubbers, at 3/8 inch deflection, shall be 3 to 4 times the load at the adjacent equipment mount.

3. Restraint assembly for floor mounted equipment shall consist of welded steel interlocking assemblies welded or bolted securely to the equipment or the equipment bases and the supporting structure. Restraint assembly surfaces which engage under seismic motion shall be lined with a resilient elastomer, 3/4 inches thick. Restraints shall be field adjustable and be positioned for 1/4-inch clearance both vertically and horizontally or clearance as required to prevent interference during normal operation, stopping, or starting. Restraint assembly shall have a minimum rating of 1g based on independent test data.

4. Curb Mounted Equipment: Seismic restraints for equipment mounted on vibration isolation curbs shall consist of slack stainless steel cables designed to provide 1g restraint in the four primary horizontal directions based on independent test data.

5. Suspended Equipment: Restraint assembly for suspended equipment, piping, or ductwork shall consist of plow steel cable attached to steel thimbles with neoprene sleeve all specifically designed for cable service and securely fastened to the equipment, or the equipment base and the building structure. Cables shall be sized for a force of 1g with a minimum safety factor of 2 based upon independent test data. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation, starting, or stopping.

6. Testing: Seismic restraint tests shall be conducted in an independent laboratory or under the supervision of an independent registered engineer. The snubber assemblies shall be bolted to the test machine as the snubber is normally installed. Test reports shall certify that neither the elastomeric nor the snubber body sustained any obvious deformation after release of load.

1.2 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1	Minimum Design Loads for Buildings and Other Structures
ASHRAE CH 52	Handbook, HVAC Systems and Applications, Sound and Vibration Control
IBC	International Building Code, Latest Edition w/ Georgia Amendments

1.3 SUBMITTALS

The following information shall be provided in accordance with the General Conditions:

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Scale drawing of Type D mounting hanger showing the 30 degree arc capability.

C. Manufacturer and manufacturer's type designation.

D. Manufacturer's catalog data.

PART 2 – PRODUCTS

2.1 ACCEPTABLE PRODUCTS

Vibration isolation mountings and seismic restraints shall be as manufactured by Mason Industries, Inc., Korfund Dynamics Corporation, Consolidated Kinetics Corporation, or equal. Flexible connectors shall be provided by the manufacturer of the mechanical equipment item in accordance with the recommendations of the vibration isolation system engineer.

2.2 BASES

A. Curb Mounted Bases: Curb mounted equipment where vibration isolation is required, principally roof top heating, ventilating and air conditioning equipment, shall be mounted on vibration isolation bases that fit over the curb and under the isolated equipment. The extruded aluminum top and bottom members shall contain cadmium-plated springs having a 1-inch minimum deflection with 50 percent additional travel to solid. Spring diameters shall be no less than 0.8 times the spring height at rated load. Wind resistance shall be provided by means of resilient snubbers in the corners with a minimum clearance of 1/4 inch so as not to interfere with spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof flexible neoprene connection duct joining the outside perimeter of the aluminum members. Foam or other contact seals are unacceptable at the spring cavity closure. Caulking shall be kept to a minimum.

B. Type I Bases: Type I bases shall be structural steel bases. The bases shall be rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases, which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10 of the longest dimension of the base. Beam depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 inch.

C. Type II Bases: Type II bases shall be steel members used to cradle machines having legs or bases that do not require a complete supplementary base. All members shall be sufficiently rigid to prevent strains in the equipment. Height saving brackets shall be employed in all mounting locations to provide a clearance of 1 inch below the base.

D. Type III Bases: Type III bases shall be rectangular foundations consisting of concrete filled structural steel beam or channel forms. Bases for split case pumps shall be of sufficient size to provide support for suction and discharge base ells. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer or required for mass or rigidity. In general, base depth shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches. Forms shall include, as a minimum, concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers each way in a layer 1 1/2 inches above the bottom or additional steel as required by structural conditions. Forms shall be provided with drilled steel members

with sleeves welded below the holes to receive equipment anchor bolts where the anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 1-inch clearance below the base.

E. Type IV Bases: Type IV bases are specified in Section 11002. They are cast iron bases and, as specified in paragraph 11021-1.1 B, are not permitted when equipment is furnished with vibration isolators.

2.3 VIBRATION ISOLATION MOUNTINGS

A. Type A Mountings: Type A mountings shall be double deflection neoprene mountings having a minimum static deflection of 0.35 inches. All metal surfaces shall be neoprene covered to avoid corrosion and shall have friction pads both top and bottom so that they need not be bolted to the floor. Bolt holes and anchor bolts shall be provided where required to resist lateral migration. Resilient washers and bushings shall be provided to prevent contact between the bolts and the equipment support bases. On equipment such as small vent sets, steel rails shall be used above the mountings to compensate for the overhang.

B. Type B Mountings: Type B mountings shall be free-standing spring type isolators laterally stable without any housing and complete with 1/4-inch neoprene acoustical friction pads between the base and the support. Mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 times the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall be hot-dip galvanized steel.

C. Type C Mountings: Type C mountings shall be Type B mountings with a housing having vertical limit stops to prevent spring extension when weight is removed. Type C mountings shall be provided for equipment with operating weight different from the installed weight, such as chillers, boilers, etc., and equipment exposed to the wind, such as cooling towers. The housing shall serve as blocking during erection and shall be located between the supporting steel and roof or the grillage and dunnage as shown on the drawings. The installed and operating heights shall be the same. a minimum clearance of 1/2 inch shall be maintained around restraining bolts and between the housing and the spring to prevent interference with the spring action. Limit stops shall be out of contact during normal operations. Mountings shall be hot-dip galvanized steel.

D. Type D Mountings: Type D mountings shall be steel hangers which contain a steel spring and a 0.3-inch deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing which passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be of sufficient size to permit the hanger rod to swing through a 30-degree arc before contacting the hole. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection.

E. Type E Mountings: Type E mountings shall be double deflection, cork and rubber sandwich pads consisting of a high-density cork layer permanently bonded to top and

bottom layers of corrugated oil-resistant synthetic rubber. The corrugated design shall allow deflection to increase with load and shall form a nonskid surface to resist lateral migration of the equipment. Bolt holes and anchor bolts shall be provided where required to resist migration. Resilient washers and bushings shall be provided to prevent contact between the bolts and the equipment support bases.

2.4 PRODUCT DATA

The following information shall be provided as product data in accordance with the General Conditions:

A. Pre-construction data:

All information specified shall be transmitted to the Engineer a minimum of four (4) weeks prior to construction.

1. Design drawings and calculations for vibration isolation system, anchorage and seismic restraints. The drawings and calculations shall be sealed and submitted by the design professional specified in paragraph 11021-1.1 C through the Contractor. The Design Professional shall affirm that loads on structures are within the load limits noted on the contract documents.

2. Manufacturers' product literature on each type of product and isolation system used including coupling, fittings, restraints or other item provided pursuant to this section.

3. Supports and vibration isolation system drawings for equipment depicting supports, locations of support, fittings and restraints, seismic restraint provisions, and other pertinent information, including wall and floor penetrations, where applicable. Submitted layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, angles and vertical and horizontal structural and equipment locations shall be determined by Contractor and depicted on layout drawings. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

4. Layout drawings and other Product Data shall be defined and depicted by system.

B. Post-Construction Data:

1. Seismic system design calculations as specified in paragraph 11021-1.1 C.
2. Seismic restraint test reports specified in paragraph 11021-1.1 E.
3. Installation report specified in paragraph 11021-3.2.
4. Static and dynamic deflections, weights, isolator locations, and flexible connector designs.
5. Spring deflections and diameters, compressed spring heights and solid spring heights.
6. Curb mounted base seal and wind resistance details.

7. Seismic restraint load deflection curves up to 1/2-inch deflection along the three principal orthogonal axes.
8. Inspection reports, authored, sealed and signed by the Design Professional retained under the provisions of paragraph 11021-1.2 A. shall be submitted to the Engineer. The Design Professional's final report shall be submitted to the Engineer before beneficial occupancy by the Owner, as required in the General Conditions.

PART 3 – EXECUTION

3.1 GENERAL

Seismic restraints shall be securely anchored or fastened to the equipment and supporting structure in accordance with approved submittal data. Operating clearances shall be adjusted so that restraints do not interfere during normal operation of the equipment.

3.2 FIELD INSPECTION

The vibration isolation support manufacturer, or his qualified representative, shall provide such supervision as is necessary to assure correct installation and adjustment of the isolators and seismic restraints. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report in writing certifying the correctness of installation and compliance with approved submittal data.

END OF SECTION

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SECTION 11134
SLUDGE GRINDERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of in-line sludge grinders and associated control panels with accessories complete. 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.

2. Equipment provided under this specification shall be of the twin shaft, counter-rotating differential speed type with intermeshing cutters. The grinders shall be the in-line type with an oversized cutter chamber. The space between the rotating cutters and the cutting chamber sidewalls shall avoid short-circuiting of the cutting elements.

3. The manufacturer shall review the mechanical layout drawings to familiarize themselves with the location and set-up of the equipment specified and shall assure themselves that the equipment specified is appropriate for and coordinated with what is shown on the contract drawings.

4. 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.

5. The manufacturer shall also review the relevant electrical plan and one-line diagram and the relevant process and instrumentation diagram drawings to ensure that the contract drawings are appropriate and coordinated with the equipment controls specified and the monitoring and protection devices shown on the P&ID.

B. Type:

1. Grinder shall be motor driven dual-shaft type with vertical motor. Grinder shall be rated for continuous duty for the application of continuous grinding of typical primary sludge at a combined sewer overflow wastewater treatment plant. Grinder shall be rated for severe-duty and shall have very high abrasion resistance.

2. Two-shaft design shall consist of two parallel shafts alternately stacked with individual intermeshing cutters and spacers cutters positioned on the shaft to form a helical pattern. The shafts shall counter-rotate with the idler shaft operating at approximately two-thirds (2/3) the speed of the drive shaft.

C. Related Work Specified Elsewhere:

1. Section 01600, General Material and Equipment Requirements

2. Section 09900, Painting.

3. Section 16150, Electric Motors.

4. Division 17, Instrumentation and Control.

5. Division 15, Mechanical.

6. Division 16, Electrical.

7. Section 01664, Training

8. Section 01650, Facility Startup

1.2 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 Electrical Code.

2. NEMA, 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. AGMA, American Gear Manufacturer's Association.

8. AFBMA, Anti-Friction Bearing Manufacturer's Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a

list of such installations with installation description, contact names, addresses and telephone numbers.

C. Unit Responsibility: The Contractor shall assign unit responsibility as specified in paragraph 11000-1.02 C and Section 01600 to the grinder manufacturer for the equipment specified in this section. A certificate of unit responsibility shall be provided as part of the equipment submittals as specified in paragraph 1.03 of this Section.

1.3 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. A copy of the specification section in question, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will denote compliance to the specifications. The submittal shall be accompanied with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, shall be rejected with no further consideration.

2. A copy of any contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in the submitted section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

3. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this Section, Section 01600 and paragraph 11000-1.02 C. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

4. Complete manufacturer's detailed drawings and literature for the grinders being furnished. The literature shall include:

   a. material of construction

   b. parts identification

c. dimensions

d. design features

e. operation and maintenance requirements

f. gear reducer information and data sheets

g. information on bearings and seals

h. pressure drop curves

i. pressure drop at specified conditions

5. Control panel descriptive literature and schematic control diagrams.

6. Power wiring diagrams for each type.

7. Manufacturers written certification that the factory applied coating system(s) is identical to the requirements specified herein. Where, in the manufacturer's opinion, the coating system(s) exceeds requirements specified herein, submit complete technical literature of the proposed system(s) to the Engineer for review.

8. Relevant experience references.

9. Manufacturer's certification.

10. Manufacturer's data.

11. Operation and maintenance manuals.

12. Motor data form 16150-A as specified in Section 16150 and Section 01600.

13. Warranty information and certification. Manufacturer shall also include information on preventative and routine maintenance requirement as well as documentation requirements necessary to maintain the equipment warranty.

1.4 QUALITY STANDARDS

A. The grinders shall be furnished by a single manufacturer who shall assume full 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. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:

1. Moyno, Annihilator,

2. JWC Environmental, Muffin Monster,

3. Or equal.

The product shall be modified as necessary to meet the requirements of this specification.

1.5 WARRANTY

A. Contractor shall provide a one year standard warranty in accordance with the General Conditions against defective equipment and poor workmanship.

B. In addition, Contractor shall also provide the Owner with an extended limited warranty for the grinders including the motors, controls and seals provided as part of this Section with respect to the specified performance criteria. The warranty must be supplied to the Owner by the Contractor prior to start-up of the equipment and must be in a form acceptable to the Owner. The warranty shall be limited to all direct costs, including labor, and consequential costs relating to any required remedy, including replacement of the equipment, associated with failure of the equipment to perform as specified, consistent clogging and torque cutoff of the grinders, premature failure of the bearings, seals and / or cutting bars during the warranty period. The warranty shall cover the period during initial start-up and testing and from the date of expiration of the Contractor's standard one year warranty for a period of 1460 days to allow for evaluation of equipment life and structural integrity over a period of 5 years. 1.06 EQUIPMENT NUMBERS

Item	Equipment No.
Sludge Feed Grinders	82G3612 & 82G3614

PART 2 – PRODUCTS

2.1 GENERAL

A. Electrical equipment required to complete the work under this section shall conform to the applicable requirements of Division 16 ELECTRICAL.

2.2 SERVICE CONDITIONS

A. The grinders will be located at a wastewater treatment plant where frequent wash downs can be expected. The temperature of the waste material is expected to vary between 50 degrees F and 104 degrees F, and pH is expected to range between 6 and 8. Grinders will be subjected to ambient temperature range of 40F to 100F and up to 90% relative humidity.

B. The equipment shall be capable of continuous operation with or without the liquid flow passing through it and shall operate without an external source of water for flushing seals or cutter blades. The design shall also permit removal and replacement of internal rotating parts without removing the grinder side housings or disconnecting the flanges from the piping system.

2.3 PERFORMANCE REQUIREMENTS

A. General: The grinder shall be designed to be installed as shown in a process pipeline to continuously macerate primary sludge from a combined sewer overflow wastewater treatment plant. Solids to be encountered during operation of the grinders are those typically found in wastewater and include heterogeneous mixtures of organic and inorganic material. Concentrations of solids are expected to range up to 5 percent. Organic solids include fecal material, vegetable parts, rubber goods, plastics, paper products, bones, small chunks of wood and semi-solid grease particles. Inorganic solids will include rocks, sand, and metal pieces of various sizes and composition. The liquid is expected to contain oil, grease, petroleum products, solvents, and water.

B. The equipment shall be capable of operation either with or without liquid in the pipeline, and shall operate without an external source of water for flushing seals or cutter faces. The design shall also permit removal and replacement of internal rotating parts without removing the grinder side housings from the piping system. The grinder shall be supplied with ANSI B16.1 125 pound flanges.

C. The grinder shall be provided with a dedicated controller to control operation of the machine. The controller shall have sensors designed to detect motor overload and initiate momentary reversal of cutter operation to cure the condition, and then resume normal operation. If the overload clears, normal operation shall be maintained. If the overload reoccurs, the process shall be repeated. If overload still remains after three attempts within 30 seconds, the controller shall lock out the grinder's control circuits and initiate alarm through dry contacts to an external circuit.

D. Characteristics: Equipment furnished under this section shall conform to the following:

Grinder	Equipment Numbers
	82G3612 & 82G3614
Pipe size, inches	6
Rated capacity, gpm	700
Maximum pressure loss at rated flow, feet	1.23
Cutter Teeth Assembly, number	2
Cutter Size	4.75” diameter cutters
Cutter tooth:	11

Root diameter overlap, inches	1/8”
Motor	
Horsepower, maximum	3
Type	TEFC

2.4 GRINDER CONSTRUCTION DETAILS

A. Each grinder body shall be cast iron, complete with clean out cover on inlet and outlet side. Inlet and outlet flanges shall be drilled to 125 pound ANSI B16.1 Standard.

B. Each grinder shall be composed of two shafts, 2 inch hexagonal shape, and constructed of Type 4140 alloy steel. The shafts shall rotate in opposite directions. The first shaft speed shall not exceed 60 rpm; the second shaft speed shall not exceed 40 rpm.

C. Grinder seals shall be mechanical seals with silicone carbide face materials. Seals shall require no external water source. The grinder bearings shall be ball bearings. Shaft radial and axial loads shall be borne by four sealed oversize Conrad-type ball bearings, which will be rated by the bearing manufacturer with a minimum basic dynamic load rating of 7050 pounds. The bearings will be protected against the intrusion of any foreign particles by a combination of a tortuous path device and end-face mechanical seals. Face materials must be a minimum of tungsten carbide to tungsten carbide, not requiring an external flush. The mechanical seal will be rated at 90 psi continuous duty by the manufacturer. Bearings and seals shall be housed in a replaceable cartridge.

D. Intermeshing cutters and spacers shall be composed of 4130 steel and through-hardened Rockwell 45-50 C surface ground steel. The cutters shall be self-cleaning. The cutters shall be of the eleven tooth design with two leading cutting edges on each tooth so as to cut in each direction without removing the cutters from the grinder. Grinder design shall include cutter bar design that can also be turned upside down and reused when worn on one side while maintaining the same direction of flow. Cutters shall be arranged in a stack such that it forms a reversible cartridge which can be pulled out from the grinder body and turned upside down and inserted back in the grinder.

E. Grinder speed reducers shall be planetary gear reducers with a speed reduction ratio of 29:1, an applied service factor of 1.2, and a "Heavy Shock" load classification.

2.5 DRIVE MOTORS

A. All motors shall conform to the applicable portion of Section 16150, Electric Motors.

B. Motors provided with this equipment are:

	Equipment Numbers	Motor Type	Min. HP	Voltage	Speed

Sludge Feed Grinders	82G3612 & 82G3614	TEFC	3	3 Phase/60 Hz/460 V	1,760 RPM* *Confirm with Manufacturer

2.6 CONTROL PANELS

A. The following panels shall be supplied under this section by the manufacturer/supplier of the equipment specified under this section:

Grinder Field Panel No.	NEMA Rating	Enclosure Material of Construction
82-CP-3612 & 82-CP-3614	4X	316 Stainless Steel

B. The following operator controls and indicators shall be furnished with each field panel:

Quantity	Item/Description
1	Forward/Off/Jog Selector Switch
1	Local/Off/Remote Selector Switch
1	Power On Indicating light, Amber lens
1	Run Indicating light, Green lens
1	Jammed Indicating light, Red lens
1	Fault/Overload Indicating light, Red lens

Control panel shall include reversible starter and additional controls as shown on the P&IDs and as required for the functionality requirements specified in the Section 17100.

C. Provide the following external interfaces.

1. Grinder Fault (Fail).
2. Grinder RUNNING.
3. Grinder Jammed
4. Grinder In-Remote Contact for L/O/R switch
5. Grinder remote RUN command.

D. Discrete outputs shall be isolated SPDT contacts rated for 5 amps continuous at 120V ac, minimum. Discrete inputs shall be isolated contact closure rated at 2 amps continuous at 120 mV ac.

E. Assembly:

1. The assembled panels and individual components shall be UL Listed and labeled.

2. Equipment and components shall be Underwriters Laboratory (UL) listed for the purpose per Section 16000 or UL recognized.

3. The control panels shall have factory applied UL 508A labels.

4. Control panel shall be provided with a lockable flange mounted disconnect.

F. Factory Testing: Prior to shipment, the manufacturer shall test the functional operation of the panel as described in the functional requirements.

2.7 FUNCTIONAL REQUIREMENTS

A. Indicate RUN status of Grinder and ON status of panel power.

B. Provide LOCAL/OFF/REMOTE control of the Grinder. Provide local Forward/Off/Jog control of the Grinder. In REMOTE, the Grinder shall RUN in response to a remote RUN command contact closure.

C. Monitor jamming of the Grinder in LOCAL and REMOTE. If jamming (overload) is sensed, the Grinder shall STOP and its rotation reversed to clear the obstruction. The Grinder shall STOP once again, and then shall resume normal forward rotation. If the OVERLOAD has cleared, the controller shall reset its counting circuit after nominally 30 seconds. If jamming still exists, the reversing cycle shall be performed two more times after which the Grinder shall be DISABLED and the JAMMED output signal shall be generated and the JAMMED light shall be activated. Grinder shall remain DISABLED and in JAMMED condition until manually RESET.

D. Low voltage motor protection shutdown shall generate an OVERLOAD output signal and activate the OVERLOAD light until manually RESET.

2.8 ELECTRICAL SYSTEM

A. Power Requirements: The power supply to each Grinder System will be a single 480 volt, 3-phase, 60 Hz, 15-amp circuit routed to the motor field control panel. The available fault current at that point will be 22,000 amps, rms symmetrically. Provide a suitably rated power circuit disconnect switch with externally operable handle in the field control panel. The power supply circuit will be terminated on the line side of this main disconnect switch. The supplier shall provide a system complying with the requirements of Division 16, ELECTRICAL.

B. Special Requirements: Provide motor controller to operate and protect the grinder. Controller shall be a solid state electronic device capable of continuous duty. Controller shall be provided with line transient protection to 1,000 volts and shall be provided with low voltage protection.

2.9 ACCESSORIES

A. A 16 gauge stainless steel identification plate shall be securely mounted on each grinder in a readily visible location. The plate shall bear the ¼ inch die stamped equipment identification numbers that are assigned herein and shown on the Drawings.

B. Each grinder shall be provided with a lifting eye, capable of lifting the entire weight of the grinder assembly, on the main body and the motor for ease of removal and maintenance.

2.10 PRODUCT DATA

A. The following product data shall be provided in accordance with the general conditions and Section 01600:

1. Motor product data specified in Section 16150 and motor data form as specified in Section 01600.

2. Product data for equipment control devices specified in paragraph 2.06 of this Section.

4. Completed Installation Certification Form 11000-A (Section 01600) specified in paragraph 11134-3.04.

5. Completed Training Certification Form 11000-B (Section 01600) specified in paragraph 11134-3.04.

6. Warranty information along with required preventative and periodic maintenance requirements and required documentation to be maintained for the warranty.

PART 3 – EXECUTION

3.1 SHIPMENT, PROTECTION AND STORAGE:

A. Equipment shipment, protection and storage shall conform to the requirements specified in Section 01610.

B. Spare parts and spare grinder units shall be tagged and stored on site with accordance with Section 11000 and the General Conditions. Provide one set of spare parts for each grinder unit.

3.2 PAINTING

A. Exposed metal surfaces shall be factory prepared, primed and finish coated with the manufacturer's standard protective coating system, provided it meets or exceeds the requirements Section 09900.

B. Finish color shall be as selected by the Owner and the Engineer during the submittal review process.

3.3 TESTS

A. All equipment and systems shall be tested in accordance with the requirements of Sections 11000 and 01650.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be provided in accordance with the requirements of Section 01664 and Section 01650 and the following specific requirements.

B. Manufacturer’s representative shall inspect and certify the installation of specified equipment at the site that it meets the recommended requirements for proper equipment installation.

C. A technically qualified manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum person-days listed for the services herein under, travel time excluded:

1. 2 man days for installation assistance, inspection, and written certification of the installation.

2. 2 man days for functional testing and training of City personnel.

D. Startup services and training of City personnel shall be in accordance with the provisions of Section 01650 and at such time as requested by the Engineer.

+++END OF SECTION 11134+++

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SECTION 11345

RECTANGULAR TANK CHAIN-AND-FLIGHT SLUDGE COLLECTORS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install chain-and-flight clarifier equipment, complete and operational.
   2. Included, but not limited to, are the following features:
      a. Rectangular tank equipment including chains, flights, sprockets, shafts, bearings, rails, supports, and appurtenances specified in this Section.
      b. Drive unit complete with reducer, motor, and overload device, as specified in this Section.
   3. Refer to Exhibit C5, Intrenchment Creek CSO Treatment Plant Sludge Collector Shop Drawings, for information on existing anchorages and equipment.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before chain-and-flight clarifier equipment Work.
   2. Effluent Troughs and Support Frame System:
      a. Rectangular tank chain and flight sludge collection equipment manufacturer shall coordinate the equipment with the existing effluent trough equipment relative to trough and support framing sizing and layout so that support framing does not interfere with sludge collector mechanisms.

C. Related Sections:
   1. Section 03600, Grout.
   2. Section 05051, Anchor Systems.
   3. Section 09900, Painting.
   4. Section 11000, General Requirements for Equipment
   5. Section 16150, Electric Motors.
   6. Section 17000, Instrumentation, Control, and Monitoring System General Requirements.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/AGMA 6034, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
2. AGMA Gearmotor Load Classifications.
3. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
4. AISC 316, Manual of Steel Construction ASD.
5. AISC 317, Manual of Steel Construction Volume II Connections.
6. AISC S326, Design, Fabrication and Erection of Structural Steel.
7. ANSI B29.21M, 700 Class Welded Steel and Cast Chains, Attachments, and Sprockets for Water and Sewage Treatment Plants.
8. ASTM A36/A36M, Specification for Carbon Structural Steel.
9. ASTM A48/A48M, Specification for Gray Iron Castings.
10. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
11. ASTM D570, Test Method for Water Absorption of Plastics.
12. ASTM D638, Test Method for Tensile Properties of Plastics.
13. ASTM D785, Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
14. ASTM D2240, Test Method for Rubber Property—Durometer Hardness.
15. AWS D1.1/D1.1M, Structural Welding Code-Steel.
16. NEMA ICS 6, Industrial Controls and Systems Enclosures.
17. NEMA 250, Enclosures for Electrical Equipment (1,000 volts maximum).

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have a minimum of five years experience of producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain materials and equipment included in this Section, regardless of component manufacturer, from one chain-and-flight clarifier equipment manufacturer.
   2. Chain-and-flight clarifier equipment manufacturer shall review and approve, or shall prepare, all Shop Drawings and other submittals for components furnished under this Section.
   3. Equipment shall be specifically constructed for specified service conditions. Equipment and components shall be integrated into overall chain-and-flight clarifier equipment system by chain-and-flight clarifier equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings

a. Dimensioned drawings of materials and equipment, indicating materials of construction, and drawings indicating assembly, installation, and wiring and control diagrams and drawings. Include the following:
   1) Flight dimensions and material.
   2) Wearing shoe details and locations.
   3) Return rail details. Details of all supports shall be adequate to demonstrate supports capable of withstanding loads from any direction imposed by the equipment. Details of return and warning rails at expansion joints shall be included.
   4) Chain size, weight, fabrication details, and proof load test documentation.
   5) Sprocket types and sizes, including idler sprocket details.
   6) Shaft material and sizes.
   7) Bearing types and details.
   8) Size, make, and type designation of electric motor, including mounting details.
   9) Type, specifications, details, input and output speeds, exact gear ratios, service factor, capacity, and efficiency of gear reducer units.
   10) Details and description of overload protection assembly. Details submitted shall be adequate to clearly demonstrate the adequacy of the overload protection provided by the proposed assembly.

~~b~~. Project-specific data on the equipment, including total weight of units, structural loads at supports, connection details and performance data.

2. Product Data:
   a. Manufacturer's literature, illustrations, specifications and engineering data.
   b. Coating system(s) proposed for shop-applied painting.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Special shipping, storage and protection, and handling instructions.
      b. Installation data for the equipment, including setting drawings, templates, and directions for installing anchorage devices.
      c. Routine maintenance requirements prior to start-up.
      d. Instructions for start-up and troubleshooting.
   2. Source Quality Control Submittals:
      a. Report of results of testing and inspections performed at manufacturer's shop.
   3. Site Quality Control Submittals:
      a. Report of results of operating test.
   4. Supplier Reports:
      a. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
   5. Qualifications Statements:
      a. Manufacturer, when submittal of qualifications is required by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with General Condition 28.6, Operation and Maintenance Manuals.
      b. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

D. Maintenance Materials Submittals: Submit the following:
   1. Spare Parts and Extra Stock Materials:
      a. Wearing Shoes: Full replacement set for one tank, including bolting.
      b. Flights: Two replacement flights for each collector furnished.
      c. Collector Chain: Ten: 100 linear feet with ten attachment links.
      d. Drive Chain: One complete drive chain.
      e. Sprockets: Complete set of all collector and drive sprockets for one longitudinal collector with keys, shaft collars, and bolts.
      f. Tank Bearings: Complete replacement set for one longitudinal collector.
      g. Drive Assembly: One complete drive assembly with motor, boxed and coated for long-term storage.
      h. Overload Clutch: One complete overload release clutch.
   2. Tools:
      a. Equipment manufacturer's standard chain tensioning device: quantity of two.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
   2. Comply with Section 01610, Transportation and Handling.

B. Storage and Protection:
   1. Stack and store flights in manner that protects flights from rain, sunlight, excessive heat or cold, and to prevent warping. Stacks of flights shall be level and supported at frequent intervals to prevent sagging.
   2. Comply with Section 01610, Transportation and Handling.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Description:
   1. Chain-and-flight clarifier equipment shall be suitable for collecting and removing sludge as specified. Equipment shall consist of parallel, endless

strands of chain with scraping flights attached, passing around pairs of sprockets, as shown or indicated.

2. Longitudinal collector flights shall be attached at equal intervals depending on length of chain; intervals shall not exceed ten feet.
3. Equipment Quantity and Tank Dimensions (To be verified by Contractor):
    a. Quantity of Tanks: 4;
    b. Quantity of Bays per Tank: 2;
    c. Inside Width of Each Bay: 21.75 feet;
    d. Inside Length of Tank: 152 feet;
    e. Average Sidewater Depth: 15 feet;
    f. Freeboard: 2.0 feet;
    g. Quantity of Longitudinal Collectors: 8;
    h. Number of Cross Collectors: 0.

B. Performance Criteria:
1. Material Collected and Removed: Combined sewer overflow solids.
2. Longitudinal Collector Speed: 1.0 fpm.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
1. Envirex Div. of Evoqua Water Technologies, Waukesha, WI.
2. Polychem Systems, Div. of Brentwood Industries, Inc., Phoenixville, PA.
3. Or equal.

2.3 MATERIALS AND ASSEMBLY

A. General:
1. Corresponding parts of multiple units shall be interchangeable.
2. Equipment shall operate continuously without excessive wear and shall allow development of maximum operating torque without damage to or failure of mechanism and drive components.
3. Design stresses shall not exceed two-thirds of yield point of the material in accordance with applicable provisions of AISC 303, AISC 316, AISC 317, and AISC S326.
4. Conservatively design and fabricate shafting to transmit power required. Deflection of shafting under full load shall be limited to the most-conservative values recognized for collector practice.

B. Materials: Comply with the following, unless otherwise shown or indicated:
1. Steel and Structural Steel: ASTM A36/A36M.
2. Welding: AWS D1.1/D1.1M.
3. Bolts: Type 316 stainless steel, unless otherwise specified ASTM A307.
4. Iron Castings: ASTM A48/A48M.
5. Anti-friction Bearings: Minimum L-10 life rating of 17,000 hours.

C. Drive Unit Assembly:

1. Each drive unit assembly shall have speed reducer and electric motor connected by flexible shaft coupling and mounted on a common cast-iron or welded steel base with a coupling guard suitable for the equipment.
2. Drive unit shall comply with AGMA rating and specification for moderate shock, 24-hour, full-load operation with service factor of 1.5, Class II.
3. Motors shall be in accordance with Section 16150, Electric Motors.
4. Motors shall be" totally-enclosed, fan-cooled, ball bearing; or non-ventilated type.
5. Motors shall be single-speed, 1,800 rpm nominal, not less than 0.5 horsepower, with ample power for starting and operating the mechanism under normal operating conditions without overloading. Provide 120-volt space heater in each motor frame.
6. Motors shall be suitable for operation in 110 degree F ambient temperature at a 1.15 service factor on 460-volt, 3-phase, 60 Hertz power supply.
7. Provide jog-type reversing switch in NEMA 4X enclosure for each unit.
8. Speed reducers shall be helical or combined helical-worm gear type enclosed in cast iron or welded steel weatherproof casing. Worm gear type shall comply with ANSI/AGMA 6034.
9. Speed reducer moving parts shall be immersed in oil, and bearings shall be anti-friction. Provide casings with inspection covers, oil fill, drain connections and means for inspecting oil flow. Inspection, oil fill, and drain covers shall be chained to casing.
10. Chain pull and bending moment on output shafts shall not exceed equipment manufacturer's rating and recommendations.
11. Provide drive chain tightener for each drive consisting of steel idler sprocket plate with slotted holes and an idler sprocket.

D. Drive Chain:
1. Collector drive chain shall be NH78 non-metallic acetal or nylon having 2.61-inch pitch links. Drive chain shall have a rated working load of at least 1,740 pounds.
2. Provide chain tightener to take up slack.
3. Provide chain drive above operating platform with removable metal guard of 316 SS.

E. Provide Non-metallic Collector Chain as follows:
1. Collector chain shall be NCS-720-S chain for heavy-duty sludge collector service, having six-inch pitch links. Chain shall have a published working load of not less than 3,100 pounds based on strength, fatigue, and wear considerations. Chain barrel shall have a wrap of 300-series stainless steel to increase chain life in a high grit environment. .
2. The attachment links shall be of similar construction to the plain chain links, with the flight pusher plate extending the full depth of the flight and molded integrally with the link sidebars. The attachment mounting hole spacing shall conform to ASME B29.21M-2013 and shall accommodate four (4) 3/8-inch (10 mm) diameter Type 316 stainless steel hex head attachment bolts. Bolts shall be fastened with Type 316 stainless steel "Nylon ring" hex locknuts and Type 316 stainless steel flat washers or standard Type 316 stainless steel nuts

and lock washers. The attachment link shall be capable of twisting a minimum of 7 degrees across the face of the attachment without failure.

F. Sprockets:
   1. Sprockets for Collector Chains, General:
      a. Sprockets for collector chains shall be molded entirely of polyurethane, ultra-high molecular weight (UHMW) polyethylene, or nylon-6, having hardness of 70 to 80 Shore "D" in accordance with ASTM D785, and maximum water absorption rate of 1.3 percent at saturation in accordance with ASTM D570.
      b. Sprockets shall have tooth profile compatible with the collector chain.
      c. If split sprockets are used, assemble sprocket halves on shafting with two Type 316 stainless steel, full-width clamping bands, or four Type 316 stainless steel bolts that exert compressive force around hub's full periphery, thereby clamping sprocket to shaft, where required. Clamping bands shall include provisions to restrict lateral movement.
      d. Beadshaft sprockets shall have the keyway molded into the hub to restrict lateral movement of the key and ensure chain alignment.
      e. Provide wedge dogs of Type 316 stainless steel along the split line near the periphery and to draw the sprockets halves tight and maintain both diametrical and lateral alignment.
   2. Drive Sprockets:
      a. Drive sprockets shall be segmented rim replaceable teeth type that operate with the drive chain.
      b. Hubs shall be Type 316 stainless steel, with Type 316 stainless steel mounting hardware. Mold tooth segments of polyurethane or nylon 6.
      c. Drive sprocket shall be not less than 9.26-inch pitch diameter and have 11 teeth.
   3. Driven Sprocket:
      a. Driven sprocket body and tooth segment of polyurethane or cast nylon.
      b. Driven sprocket shall be not less than 33.25-inch pitch diameter and shall have 40 teeth.
      c. Assemble body halves onto headshaft with Type 316 stainless steel hardware.

G. Shafting:
   1. Headshaft:
      a. The head shaft shall be tubular construction and shall extend across the full width of the tank. The tube shall consist of biaxially wound fiberglass reinforcement that has been epoxy coated and keyed for transmission of torque. The head shaft shall have internal polymer bearings that turn over stub shaft supports mounted on the tank walls and held in place with split set collars. Shaft and sprockets shall be shipped unassembled.
   2. Shafting shall be conservatively designed and constructed to transmit power required without appreciable deflection.
   3. Idler sprockets shall be mounted to cold-rolled steel or cast nylon stub shafts with sprocket bearing sleaves.

H. Tank Bearings:
   1. Fabricate bearings using one of the following methods:
      b. Bearings shall have a minimum of 1/4-inch thick UHMW polyethylene sleeve.

I. Torque Limiting Devices:
   1. Provide an externally adjustable ball-detent type torque limiting device for each drive sprocket on output shaft of drive assembly.
   2. Each torque limiting device shall include a limit switch actuating mechanism and a limit switch. Limit switches shall be DPDT type, 10 amp at 120 volts. Limit switches shall be housed in a NEMA 4X enclosure.
   3. Torque limiters shall be initially set at 6,500 lb-in.

J. Flights:
   1. Flights shall be nominally three inches by eight inches and spaced on the collector chain at intervals of ten feet on centers, and shall be fabricated of fiberglass reinforced plastic pultrusion, with continuous filaments running the full length of flight.
   2. Flights shall have a minimum minor axis moment of inertia of 1.75 inches or modulus of elasticity of 2.5×10^6.
   3. Flights shall include filler blocks for bolting flights to chain attachment links and shall have a scraper lip on the leading edge to clean the tank floor.
   4. Provide each flight with two wearing shoes. Provide two flights in each collector mechanism with synthetic rubber squeegees to clean remaining sludge from the tank floor between wear strips.
   5. Flight water absorption shall not exceed 0.6 percent by weight, as measured by ASTM D570. Buoyant flights are unacceptable.

K. Wearing Shoes:
   1. Provide each flight with two 1/2-inch polyurethane or UHMW-PE wearing shoes to slide on the tank-mounted wearing channels, and with two similar shoes to slide on the outboard return support tracks.
   2. Shoes shall be cast of virgin material with minimum tensile strength of 6,000 psi. Shoes shall have hardness of 80/85 Shore "A" in accordance with ASTM D2240.
   3. Wearing shoes running on floor rails shall be located central to chain attachment to avoid drilling additional holes that could weaken the flight.
   4. Return-run wearing shoes shall include a guide lug to ensure proper tracking of flight with the return track where required. Wearing shoes shall be reversible providing two usable wearing surfaces.

M. Return Rails:
   1. Provide one of the following return rail systems:
      a. Option A: Return tracks shall be 1/4-inch thick Type 316L stainless steel formed shapes attached to Type 316L stainless steel brackets mounted on tank walls. Design and construct each bracket to cantilever return track

approximately nine inches from the tank wall. Maximum support bracket spacing shall be ten feet on centers.

b. Option B: Return tracks shall be corrosion-resistant fiberglass reinforced isothalic polyester resin, designed and constructed for sludge collection service. Tracks shall be fabricated by the pultrusion method for complete encapsulation in resin of glass fiber strands. Glass filaments and mat shall run full length of the section. Full member shall comply with minimum glass by weight requirements in accordance with ASTM D638. Resin shall contain inhibitors to protect material from degradation caused by ultraviolet light. Rail system shall utilize a design that minimizes the quantity of mounting hardware for splices and mounting brackets.

O. Anchorage Items:

1. Provide all anchor bolts, nuts and other fasteners required for connection of the equipment and appurtenant items to the structure or base pads. Shake proof lock washers shall be used on all bolted connections. All bolt heads and nuts shall be hex-head design, except as noted. Length of bolt shall extend a minimum of two threads through nut.
2. Except where size is shown or specified, anchorage items shall be sized by manufacturer for ample strength for purpose intended and shall be installed in accordance with his instructions.
3. Bolts, Nuts and Other Fasteners: Type 316 stainless steel, unless otherwise specified.
4. Anchor bolts shall comply with the requirements of Section 05051, Anchor Systems.

P. Wear Strips:

1. The return tracks and floor shall be lined with removable wear strips of UHMW polyethylene material in ten-foot sections with each section having a minimum of three countersunk holes and fastened with Type 316 stainless steel hardware suitable for field attaching wear strips to the tops of the tracks and floor. All splices shall be mitered at 45 degrees, vertically, to allow for a smooth transition of the wear shoes in the direction of flight travel to prevent the shoes from hanging up on an uneven edge. Wear strips shall have a full 1/2-inch of wear surface above any mounting hardware. If 1/4-inch of material is required for mounting, the wear strip must be 3/4-inch thick.

2.5 FINISHING

A. Equipment motors, frames, and appurtenances shall receive shop primer in accordance with Section 09900, Painting. Do not paint stainless steel, plastic, or machined components.

B. Surface preparation and painting shall be in accordance with Section 09900, Painting.

C. Gears, chains, bearing surfaces, machined surfaces and other surfaces that are to remain unpainted shall receive a heavy application of grease or other corrosion-inhibiting coating. Maintain coating during storage and until equipment is placed into operation.

D. Field Painting: Comply with Section 09900, Painting.

2.6 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Upon completion of manufacture of equipment and appurtenances, conduct manufacturer's standard shop tests prior to shipment. Shop tests shall be conducted using materials and equipment to be furnished for the Project.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install products in conformance with Laws and Regulations, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.

B. Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents.
   2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted thereon shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03600, Grouting. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2-inch.

C. General:
   1. Where tank bottom rails cross expansion joints, chamfer rails and cut rail ends at 45 degree horizontal angle to provide smooth travel over the joint.
   2. Perform all drilling and fitting required for installation. Set equipment accurately in location, alignment, and elevation, plumb, true, and free of rack.
   3. Making plate cutouts or openings in the field is not allowed.
   4. Fit exposed connections accurately together to form tight hairline joints.

5. Secure plates to supporting members or frames with zinc or cadmium coated machine screws for steel, and stainless steel screws for aluminum and stainless steel.
6. For contact surfaces between aluminum and dissimilar surfaces, use a coat of bituminous paint or other approved insulating material.
7. Align and adjust equipment including motors, belts, and drives, in presence of ENGINEER.
8. Align and adjust equipment in accordance with equipment manufacturer's instructions.
9. Prior to energizing electric motor-driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.

D. Comply with Section 01650, Facility Startup.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
1. After installation, CONTRACTOR and qualified field service representative of manufacturer shall conduct at the Site operating tests of equipment, including all functions, and controls, in presence of ENGINEER.
2. Field Operating Test:
   a. Field test equipment and associated controls in local mode as applicable, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part individually and all parts together function properly in manner intended. Equipment shall operate free of vibration, jamming, jerking, and overheating to satisfaction of ENGINEER. Total duration of testing shall be 8 hours, continuous and uninterrupted, in automatic mode. All testing equipment and labor shall be by CONTRACTOR.
   b. Should tests indicate defective Work, including malfunctions, make necessary repairs, revisions, and adjustments and restart test from the beginning. Repeat tests and repairs, revisions, and adjustments until, in ENGINEER's opinion, installation is complete and equipment is functioning properly and accurately, and is ready for permanent operation.

B. Manufacturer's Services: Provide a qualified, factory trained serviceman to perform the following:
1. Supervise unloading and installation of equipment.
2. Instruct CONTRACTOR in installing equipment.
3. Inspect and adjust equipment after installation and ensure proper operation.
4. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
5. Manufacturer's technician shall make visits to the Site as follows:
   a. First visit shall be for supervising unloading and handling of equipment and for instructing CONTRACTOR in proper equipment installation, and

assisting in installing equipment. Minimum number of hours on-Site: 8 hours.

b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Minimum number of hours on-Site: 24 hours.

c. Third visit shall be to instruct operations and maintenance personnel.
   1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.
   2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01664, Training.
   3) Number of hours on-Site shall be in accordance with Section 01664, Training.

d. Technician shall revisit the Site as often as necessary until installation is acceptable.

5. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

+ + END OF SECTION + +

SECTION 11358
POLYMER FEED EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of liquid polymer preparation and feed systems and polymer tote mixers. 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. Related Work Specified Elsewhere:

1. Section 09900, Painting.
2. Section 11000, General Requirements for Equipment
3. Section 11400, Package Control Systems.
4. Section 16150, Electric Motors
5. Section 17000, Instrumentation, Control and Monitoring System General Requirements
6. Section 17260, Process Control Panels and Hardware

1.2 SUBMITTALS

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

A. Manufacturer's certification: The CONTRACTOR shall obtain written certification from MANUFACTURER, addressed to the OWNER, stating that the equipment will efficiently and thoroughly performed the required functions in accordance with these specifications.
B. Information on all electrical items.
C. Field Instrumentation information in accordance with the requirements on specification Section 17000, Instrumentation, Control and Monitoring System General Requirements.
D. Complete wiring schematics and point to point diagrams.
E. Control panel layout and wiring diagrams in accordance with the requirements on specification Section 17000, Instrumentation, Control and Monitoring System General

Requirements.

F. MANUFACTURER'S catalogue information, descriptive literature, specifications, and identifications of material of construction.

G. Shop drawings: Contractor shall submit shop drawings and samples in accordance with the Specifications.

H. O&M Manuals: The CONTRACTOR shall provide operator and maintenance data for all equipment furnished for this project in accordance with General Conditions GC-28.

I. Tools: Special tools necessary for maintenance and repair of the equipment shall be furnished as a part of the WORK hereunder. Such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solids plastic tags attached to the box.

1.3 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 that have been in successful operation for a minimum of three years. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. This reference list shall be submitted with the shop drawings.

C. CONTRACTOR shall submit the following:

1. MANUFACTURER'S Certificate of proper Installation.
2. Functional Test Certification.
3. Factory Performance Test Reports.
4. Special shipping, storage and protection, and handling instructions.
5. MANUFACTURER'S printed installation instructions.
6. Suggested list of spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacements, and maintenance.
7. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup.

1.4 QUALITY STANDARDS

A. The polymer systems 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. 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.

B. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the pump manufacturer shall not be accepted.

C. 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.

D. Manufacturer's offering products that comply with these specifications include:

1. Polymer system.
   a. UGSI Chemical Feed, Inc. - PolyBlend
   b. Prominent Fluid Controls, Inc.
   c. Fluid Dynamics - dynaBLEND
   d. Polydyne, Inc.
   e. Or equal.

2. Neat Polymer Pump.
   a. Progressive Cavity Pumps
   b. Or equal.

3. Polymer Tote Mixer.
   a. Neptune
   b. Or equal

1.5 DELIVERY, STORAGE AND HANDLING

All equipment shall be stored and protected in accordance with the manufacturer's written recommendations.

1.6 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.7 EQUIPMENT NUMBERS

Polymer Feed System 1	83POLY3701
Polymer Tote Mixer 1	83MX3701

PART 2 - PRODUCTS

2.1 GENERAL

A. The liquid polymer preparation systems shall be located in the proposed Sludge Dewatering Building and the Sludge Pump Building as shown in the Drawings. Each skid mounted systems shall be capable of preparing up to 1,200 gallons per hour of 1 percent polymer-to-water solution.

B. Polymer feed pump shall be mounted on each system skid.

2.2 COMPONENTS

A. Polymer Feed System:

1. General

a. The Contractor shall provide a complete liquid polymer dilution feed system capable of producing diluted polymer-to-water solution in the 0.2 to 1 % range.
b. The polymer mix/feed system shall be an integrated equipment package to automatically meter, dilute, mix, activate, and feed liquid/emulsion polymer with active contents up to 50 percent.
c. When dilution of concentrated liquid polymer is performed, the automatic polymer dilution/feeder systems shall use a method for blending concentrated polymer and water which provides a mean swell time of not less than 30 seconds. All metallic materials of construction shall be 316 stainless steel or brass.
d. Operation shall be continuous feed.
e. The polymer dilution/feed systems shall be mounted onto a common baseplate skid and delivered pre-wired, pre-piped and pre-tested from the factory. Only simple plumbing and electrical connections shall be necessary to complete the installation.
f. The major components of each system shall be as follows: mixing chamber, brass rotameter, isolation ball valves, check valves, pressure relief valve, calibration cylinder, coupling guard, progressive cavity pump, motor, variable frequency drive controller and all associated instruments. All components shall be skid mounted.
g. Each polymer system shall include a polymer metering pump, capable of pumping liquid or emulsion polymers with viscosities up to3,000 centipoises.
h. Mixing chambers that utilize conventional static mixers or eductors are not acceptable.
i. All motors and controls shall be interconnected to require a single 120-volt, 60-Hertz, single-phase connection to each unit.
j. Skid shall be constructed of Type 316 stainless steel.

2. Pump construction details:

Pump type	Progressive cavity, single stage
Body	Stainless steel, type 316
Rotor	Stainless steel, type 316
Shaft	Stainless steel, type 316
Pump/Driver arrangement	Each pump shall be driven using a gear
Stator	Viton
Joints	Gear-type universal
Bearings Outboard end Inboard end Rating life	 Steel ball or roller thrust bearing. Steel ball or roller radial bearing 30,000 as defined by AFBMA Standards.
Bearing lubrication	Grease with, addition and relief fittings
Stuffing box	Single mechanical seal.
Stuffing box lubrication	Pumped medium shall lubricate the mechanical seal.
Provide antirotational device or other means to prevent reverse rotation of the rotor.	
Baseplate	Factory mount the complete pump and drive assembly to the skid frame.

B. Tote Mixers:

1. Provide tote mixers suitable for neat polymer mixing that meet the following design criteria: Design base model is:
   a. Neptune Model HGL 6.0 Mixer with mounting bracket
2. Mixers shall meet the following design criteria:
   a. Maintain neat emulsion polymer solution in suspension without shearing.
   b. Gear driven mixer with operating speed of 430 rpm.

2.3 PERFORMANCE REQUIREMENTS

A. Polymer Preparation System:

The polymer preparation system shall be designed to operate on a liquid polymer. Each system

shall be capable of manual or automatic operation in preparing polymer solution on a continuous basis. Each system shall be capable of making 1,200 gallons per hour of polymer solutions of 0.2 to 1.0 percent polymer-to-water concentration.

B. Polymer Feed System:

Service	**Solids Dewatering**
Polymer Type	Emulsion
Polymer Feed Range (gph)	0.1 –2.0
Positive Displacement Pumps (gph)	0.1 –2.0
Pump Discharge pressure (psi)	100
Dilution Water Flow (gph)	500 - 1,200

C. The polymer systems shall have a high shear and a low shear zone, which shall create the mixing intensity (G-Value) indicated in the following table over the full range of flow. Contractor shall submit certified calculation and/or factory testing reports showing the mixing intensity of the polymer system units over the full range of flow.

Mixing Zone	**Mixing Intensity (G-Value)**
High Shear Zone	$>14{,}000 sec^{-1}$
Low Shear Zone	$< 3{,}500\ sec^{-1}$

D. Dilution and Mixing Water (typical both systems)

1. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy to activate polymer without creating agglomeration. Water volume shall be controlled by a throttling valve. Polymer activation efficiency shall be consistent over a dilution water range.
2. Post dilution shall be an integral part of each polymer system. Dilution water shall be split into two streams. Primary water flow shall supply the mixing chamber. Secondary water flow shall be used to post dilute the activated polymer stream. These two streams shall be completely blended prior to exiting each polymer system.
3. Each polymer system shall have a rate control valve for isolation of or throttling of water flow.
4. Plant water (potable) shall be used as a dilution water source for each polymer system. The proposed polymer system shall be designed to operate on a 60 psi potable water supply system. The dilute solution leaving the polymer mixer shall have enough pressure to overcome the 12 psi at the polymer mixer on the feed line to the belt filter press.
5. Each polymer system shall be designed so that the metering pump suction is located no more than 24 inches off the base to assure reliable pump suction conditions.

2.4 MOTORS

A. Motors shall conform to the applicable portion of Section 16150, Electric Motors.

B. Motors shall be inverter duty, energy efficient conforming to the applicable portions of Section 16150, Electric Motors.

C. The pump drive motors shall be controlled via variable frequency drive controllers. These drive controllers will be located in the control panel.

2.5 INSTRUMENTATION

The polymer system skid for both systems shall include the following instrumentation:

A. Mixing chamber
B. Pressure relief valve
C. Neat polymer check valve
D. Dilution water check valve
E. Rotameter type flow meter
    1. Metering tube
    2. Internal components
    3. Fitting
    4. Elastomers
F. Dilution water on/off flow control valve (motorized or solenoid)
G. Dilution water flow rate adjustable flow control valve
H. Pressure switch
I. Neat polymer metering pump
J. Pump motor
K. Thermal type loss of flow sensor on pump
    1. Pump shall shut down when thermal switch is activated.
L. Metering calibration assembly
M. Hand vacuum pump (for priming metering pumps)
N. Static mixer
O. Associated valves and fittings for skid/drain connections

2.6 LIQUID POLYMER SYSTEM CONTROL PANEL

A. Provide unit-mounted control panel for fully automatic and manual control. Control panel construction shall be stainless steel, 316L NEMA 4X type. Fuses shall be supplied for all control devices. Control panel shall contain all starters and VFDs required for system equipment operation.

B. Panel door mounted control devices shall include: Hand-Off-Auto switch, start/stop, speed controls, speed indication, run status, fail indication and reset.

C. A common panel door mounted audible alarm shall be provided for the following: liquid feeder and low water pressure/flow.

D. A common alarm contact shall be provided for the following: Off, low water pressure/flow, and loss of polymer feed. Contact shall be wired to terminal blocks for remote alarm.

E. Control panel shall be pre-wired to all devices including power and controls. Power wiring and control wiring to the control panel shall be provided by the Contractor.

F. In the Auto mode, each polymer system shall receive start, stop and speed control from the Belt Filter Press control panel. The speed of the polymer feed pump, hence the output, would be controlled by the belt filter press control panel with a 4-20 mA signal.

G. The following minimum hardwired signal shall be available for the Belt Filter Press Control Panel.
   1. System not in auto
   2. System Fail
   3. System Run status.
   4. Speed feedback.
   5. Speed control.
   6. Flow Rate
      a. If flow rate signal is not available, control panel shall include required logic to calculate the polymer flow rate.

2.7 VARIABLE FREQUENCY DRIVE

The variable frequency drive shall conform to the requirements of this section. VFDs shall be mounted in the polymer system control panel.

2.8 SHOP PAINTING

A. All surfaces except stainless steel, shall be prepared and shop painted as part of the work under this section. Surface preparation and shop priming shall be as specified in Section 09900, Painting.

B. All gearboxes, motors and controls shall have manufacturer's standard machinery paint finish.

2.9 FACTORY TESTS

Each system shall be factory assembled and tested before being shipped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each polymer system as described in Part 2 including all appurtenances shall be installed, tested and adjusted and the installation shall be certified by the manufacturer.

B. Modifications and/or additions to the existing equipment shall be coordinated with the Engineer in such a manner that operation of the plant is not adversely affected.

C. Contractor shall supply polymer for startup and commissioning of the belt presses. Contractor shall furnish one (1) day of on-site services of a polymer sales representative who shall visit the site and determine a suitable polymer for dewatering of the plant sludges.

D. The Contractor shall furnish a minimum of three (3) days start-up services by the respective equipment manufacturer's representative(s) to ensure that the equipment has been properly installed and tested to provide continuous and satisfactory operation. The Contractor shall make, at his expense, all necessary changes, modifications, or adjustments required to assure satisfactory operation. The equipment manufacturer's representative shall also instruct the City's representative in the maintenance and operation of the equipment.

3.2 MANUFACTURERS' SERVICES

Manufacturers' services shall be provided in accordance with Section 11000 and Section 01640. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum days listed for the services herein under, travel time excluded:

Three (3) days for installation assistance, inspection, function and performance testing, training and certification of the installation.

END OF SECTION

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SECTION 11400
PACKAGE CONTROL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of package control systems with accessories complete. 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. The general requirements herein, together with the detailed requirements of the specific equipment specifications, establish the work necessary to furnish and install the package control system.

B. Major constituents of each system include, but are not limited to, all materials, equipment, and work required to implement a complete and operating system of instrumentation and controls for its associated equipment. The systems shall include primary elements for process variable measurements, analog display and control elements, and discrete display and control elements as noted hereinafter and in the associated Equipment 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 considered as being included in the price bid for the work shown and specified.

D. Related Work Specified Elsewhere:

1. Section 09900, Painting.

2. Division 15, Mechanical.

3. Division 16, Electrical.

4. Division 17, Instrumentation.

1.2 EQUIPMENT SPECIFICATIONS

Equipment specifications contain detailed descriptions of the individual package control systems which shall conform to the requirements specified herein.

1.3 DEFINITION OF TERMS

Package Control System: Package control systems include all instrumentation and controls (including but not limited to circuit breakers, motor starters, gauges, transmitters, panels, process and manual switches, indicators, and controllers) furnished under sections other than Division 17, Instrumentation. Each package control system includes all instrumentation and controls furnished under a single section.

1.4 RESPONSIBILITY FOR COMPLETE SYSTEM

The Contractor shall be ultimately responsible and shall provide for the supply, installation, (including all interconnecting conduit and wire), certification, adjustment, and startup of complete, coordinated systems which shall reliably perform the specified functions.

1.5 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. Bill-of-Material catalog information, descriptive literature, wiring diagrams, and shop drawings for all components of the control system including spares, expendables and test equipment. Include all scale ranges, set points, etc.

B. Catalog information on all electrical devices furnished with the system.

C. Shop drawings and catalog material for all control panels and enclosures.

D. Panel elementary diagrams of prewired panels. Diagrams shall include all control devices and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc.

E. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.

F. Interconnection wiring diagrams which include numbered terminal designations which show external interfaces.

G. Programmable Controller Submittals:

1. Fully documented ladder logic listings
2. Function listing for all function blocks not fully documented by the ladder logic listings
3. Hardwired I/O to software point identification cross-reference listing
4. Data highway cable connection, and communication documentation where a data highway is required.
5. A description of necessary coordination with Foxboro I/A gateway to effect required communications.

H. Relevant experience references.

I. Manufacturer's certification.

J. Manufacturer's data.

K. Operation and maintenance manuals.

L. Complete wiring and control diagrams.

1.6 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 Electrical Code.

2. NEMA, 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. AGMA, American Gear Manufacturer's Association.

8. AFBMA, Anti-Friction Bearing Manufacturer's Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

C. Should the package control systems not perform as required, the Contractor shall repair or replace any units as necessary to meet the Specifications. Costs for unit repair and retesting shall be the Contractor's responsibility.

1.7 QUALITY STANDARDS

The package control system shall be furnished by a single manufacturer who shall assume full 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.

1.8 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 – PRODUCTS

2.1 FUNCTIONAL REQUIREMENTS

A. General:

1. The Process and Instrumentation Diagrams, the Control Strategies and the equipment specifications depict the minimum functional requirements of the control systems to be provided with the package systems. The Equipment Suppliers shall provide all additional instrumentation and controls necessary to provide a safe and operable system. The specific control systems proposed shall be subject to the approval of the Engineer, and shall be submitted in accordance with Paragraph 1.05 of this Specification.

2. All instrumentation, control and electrical components provided under this section shall be of industrial quality and in conformance with the Component Specifications in Division 13, Instrumentation and Division 16, Electrical.

3. Where materials of construction, mounting methods, unit ranges, scale ranges, set points, calibrations, etc., are not indicated, provide appropriate selection and document the selection in the submittals. Engineering units shall be used.

B. Interconnecting Wiring: Prewire all electrical devices to:

1. The equipment control panel where the panel is supplied by the equipment manufacturer and mounted on or with the equipment; or

2. Common well marked terminal junction boxes for each of the following types:
   a. Power (208 volts or greater)
   b. Control, discrete (120 volt)
   c. Control, analog

C. Equipment Specification Format: Each Equipment Specification provides detailed descriptions of the following:

1. Panels. The tag number, material, NEMA rating, special requirements, and type (freestanding, surface mount, etc.) of panel(s) that shall be provided by the Equipment Supplier.

2. Operator controls and indicators. The minimum required operator interfaces that shall be provided by the Equipment Supplier.

3. External interfaces. The minimum required interfaces between the package control system and other equipment.

4. Functional requirements. The minimum functional performance requirements for the control system which can include an abstract of the functions of any interlocks, interfaces, and alarm conditions.

5. Power requirements. The power requirements and interfaces with the power source of the control systems.

6. Special requirements. Any additional requirements unique to the individual control system. This would include special component requirements, tests, onsite supervision, training, and nonstandard interfaces.

D. Tag Numbers

Tag numbers shall be as indicated herein, as shown on the Drawings, and as necessary for consistency with existing equipment tag numbers.

2.2 SIGNAL CHARACTERISTICS

A. Analog signals shall be 4 to 20 mA dc and shall conform to the compatibility requirements of ISA Standard S50.1. Unless otherwise noted, circuits shall be Type 2, two-wire or Type 4, four-wire. Transmitters shall have a load resistance capability conforming to Class L. Input and output signals of all transmitters and receivers shall be fully isolated.

B. Pulse frequency signals shall use dc pulses whose repetition rate is linearly proportional to the process variable over a 10:1 range. Pulses may be generated by contact closures or solid state switches. Power source shall be less than 30V dc.

C. Discrete signals are two-state logic signals. Control and alarm signals shall utilize 120V ac sources. All alarm signals shall be normally open (open when de-energized), open to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc continuous operation.

2.3 ENVIRONMENTAL CONDITIONS

A. Equipment rated NEMA 1 or NEMA 12 shall be suitable for the following environmental conditions:

Temperature	40 to 105 degrees F
Relative Humidity	10 to 100 percent
Classification	Nonhazardous

B. Equipment rated NEMA 4X shall be suitable for the following environmental conditions:

Temperature	40 to 105 degrees F
Relative Humidity	10 to 100 percent
Atmosphere	Corrosive
Classification	Nonhazardous

2.4 CONTROL PANELS

A. Panels shall be completely fabricated, instruments installed, plumbed, and wired in the Equipment Suppliers' factories. All wiring and plumbing shall be completed and tested prior to shipment. All external connections shall be by way of numbered terminal blocks.

B. All connections for future functions shall be wired to numbered terminal blocks, grouped separately from the terminal blocks in use. Terminal blocks shall also be grouped to keep 120V ac circuits separate from the 24V dc circuits.

C. Sufficient terminal blocks shall be provided to terminate all spare conductors. In addition, the greater of 15 percent or four unused spare terminals shall be provided.

D. Panel Construction:

1. Panels shall be enclosures conforming to the requirements of the National Electrical Manufacturer's Association for the NEMA rating noted in the individual Equipment Specifications.

2. Panel material shall be as noted in the individual Equipment Specifications. If not noted, provide Type 316 stainless steel.

3. In addition to the NEMA Standards, the panels shall conform to the following requirements:

   a. Minimum metal thickness shall be 14 gauge.

   b. All doors shall be rubber-gasketed with continuous hinge. For NEMA 1 and 12 panels, doors more than 36 inches high shall have 3-point latching mechanisms. All other doors shall have stainless steel quick-release clamps.

   c. Wherever practical, enclosures shall be a manufactured item, Hoffman, H. F. Cox, or equal.

   d. Panel cutouts for instruments and other devices (e.g., lights and switches) shall be cut, punched, or drilled and smoothly finished with rounded edges.

   e. Panels shall be so seed as to adequately dissipate heat generated by equipment mounted in or on the panel.

f. Where panels are mounted outside or in unheated areas, they shall be provided with thermostatically controlled heaters that will maintain their inside temperature above 40 degrees F.

g. Provide a hand switch controlled internal 100-watt incandescent light for panels larger than 12 cubic feet in volume.

h. Unless otherwise noted, panels shall be constructed with front access only suitable for installation with side and back surfaces adjacent to and in contact with other surfaces.

E. Control Panel Finish: All metallic external surfaces (excluding aluminum and stainless steel), shall be finished with an ANSI 61 gray polyester powder coating over phosphatized surface. Internal surfaces shall be painted with a white enamel.

F. Control Panel Electrical:

1. General. All electrical work shall be in accordance with the applicable requirements of Division 16, Electrical.

2. Power distribution within panels.

a. Control panels without motor starters. Provide master circuit breaker and a circuit breaker on each individual circuit distributed from the panel. The circuit breakers shall be grouped on a single subpanel. Provide subpanel placement so that there is a clear view of and access to the breakers when the door is open. Circuit breakers shall be Heinemann Electric Co. Series AM; Airpax/North American Philips Controls Corp. Series 205; or equal. Branch circuit breakers shall be rated for 15-ampere at 250-volt.

b. Control panels with motor starters. Control panels which have 3-phase power supplies and contain motor starters in addition to logic controls shall contain a main circuit breaker interlocked with the panel door and an interior swing-panel to provide dead front construction. All logic controls, branch circuit breakers, overload reset switches, and other control circuit devices shall mount on or through the swing-panel. Control devices and indicating lights shall be mounted on the front access door. Circuit breakers shall be operable without opening the dead front panel. The swing-panel shall have a minimum swing of 145 degrees and shall have quarter-turn hand latches. Power system components shall be as follows:

1) Circuit breakers shall meet the requirements of UL and NEMA AB1. All breakers shall have a 42,000-ampere RMS symmetrical interrupting rating, minimum, at 480 volts unless otherwise indicated in the equipment specifications. Main and branch circuit breakers, except motor branch circuit breakers, shall be molded case thermal magnetic. Provide a method for padlocking of motor branch circuit breakers in the OFF position. Motor branch circuit breakers for larger motors shall be thermal magnetic with adjustable magnetic trip units. Motor branch circuit breaker ratings shall be as recommended by the manufacturer for maximum motor protection.

Tripping of breakers shall be indicated by operator handle position. Provide circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

2) Full voltage magnetic motor starters shall meet NEMA ICS 2, Class A, NEMA size 1 minimum. Motor starters shall include 3-pole bimetallic or eutectic alloy thermal overload relays sized for the motor which it protects. Overload relays shall be manual reset type with the reset button mounted on the panel door.
3) All motor control shall be 120V ac (except intrinsically safe circuits where applicable). Provide a control power transformer that has sufficient capacity to serve the connected load including 200VA for the duplex outlet plus 100VA (minimum) and limits voltage variation to 15 percent during contact pickup. Fuse one side of the secondary winding and ground the other side. Provide primary winding fuses in all ungrounded conductors.
4) Provide a power monitoring relay to protect 3-phase equipment against single phasing, phase unbalance and phase reversal. Provide separate, isolated contact outputs to stop all motors and to activate an alarm light in the event of an abnormal condition. Power monitoring relay shall have 10,000-volt transient voltage protection and shall be Furnace Class 47, or equal.
5) Power distribution blocks shall be used to parallel feed the line side of all branch circuit protective devices. "Leap frogging" of power conductors shall not be acceptable.

3. Wiring within panels, consoles, and assemblies shall meet the following requirements:

   a. Wires for ac circuits shall be 600-volt, Type MTW stranded copper and shall be sized for the current to be carried, but not smaller than No. 16 AWG.

   b. Wires for analog signal circuits shall be 300-volt stranded copper and shall be twisted shielded pairs not smaller than No. 18 AWG.

   c. Wires for other dc circuits shall be 300-volt, Type MTW stranded copper and shall not be smaller than No. 18 AWG.

   d. All analog and other dc circuits shall be separated at least 6 inches from any ac power and control wiring.

   e. All wiring shall be enclosed in either sheet metal raceways or plastic wiring ducts. Wiring ducts shall be complete with rounded ends, covers and wire protectors.

   f. Wiring shall be numbered and tagged at each termination. Wire tags shall be snap-on or slip-on PVC wire markers with legible machine-printed markings and numbers. Adhesive or taped-on tags are not acceptable.

4. Wiring interface. Wiring entering or leaving each panel, console, rack, or cabinet shall be terminated and identified as follows:

    a. Analog and discrete signal wiring shall be terminated at numbered terminal blocks.

    b. Wiring for special signals such as communications, digital data, and multiplexed signals may be terminated at manufacturer's standard connectors.

    c. All wiring shall be identified per the requirements of Division 16, Electrical.

5. Terminal blocks for panels, consoles, racks, and cabinets shall meet the following requirements:

    a. Provide sufficient terminations to accommodate both present and future needs. Wire all spare or unused panel mounted elements to their panels' terminal blocks. Provide the greater of 20 percent of all connected terminals or four unused spare terminals. In addition to the required spares, provide sufficient terminals to accommodate the cables that are routed through that panel.

    b. Provide 300-volt for controls and 600-volt for power screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screw constructed of high strength and high conductivity metal. Use yoke that guides all strands of wire into the terminal. Use current bar providing vibration-proof connection. Supply terminals that allow connection of wire without any preparation other than stripping. Rail mount individual terminals to create a complete assembly. Provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

    c. No more than two wires may be terminated on any single terminal. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field marked tags. Provide UL approved terminal blocks manufactured by Phoenix Contact, Inc., Allen-Bradley, or equal. See Section 13200 for additional requirements.

6. Grounding. Panels, consoles, racks, and cabinets shall be provided with an internal copper grounding bus for all ground connections.

7. Relays.

    a. Relays for interfacing and control applications shall be the compact general-purpose plug-in type having low coil inrush and holding current characteristics. Contact arrangements shall be rated for not less than 10 amperes at 120V ac or 28V dc. A status indicating light shall be provided as part of each relay. Nonlatching relays shall have a single coil. Latching relays shall have two coils, unlatching being accomplished by energizing one coil, and latching being accomplished by energizing the other coil. Relays shall have plain plastic dust covers, test buttons, and rail mounting sockets with screw terminals and

holddown springs. Relays shall be UL recognized. Relays shall be Potter and Brumfield KUP or KUL Series; Struthers-Dunn Series 219; or equal.

b. Time delay relays shall be adjustable with the number of contacts and contact arrangements required. Contacts shall be rated for 10 amperes at 120V ac. Integral knob with calibrated scale shall be provided for adjustment of time delay. Time delay rangeability shall be at least 10:1. Operating voltage shall be 120V ac, at 60-Hz. Operating temperature shall be -20 degrees F to 165 degrees F. Repeat timing accuracy shall be plus or minus 10 percent over the operating range. Units shall be Square D Type JCK; Allen Bradley Bulletin 700, Type HT; or equal.

c. All relays shall have a 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.

8. Programmable controller.

a. Programmable controllers shall be all solid-state units capable of performing the same functions as conventional relays, timers, counters, and drum sequencers as well as arithmetic and other special functions necessary to perform the required control functions.

b. Units shall have a minimum of 12 discrete inputs and 8 discrete outputs. Inputs and outputs shall have optical isolation rated at 2500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.

c. Units shall have a minimum of 25 percent excess capacity for inputs, outputs, internal, coils, registers and other necessary functions.

d. Units shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.,) without fans, air conditioning, or electrical filtering. Units shall operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.

e. All manufacturer hardware and software necessary to implement and document the functional requirements herein. Units shall be programmed using conventional relay ladder diagram notation and drum sequencer chart notation. The programmer shall provide a force function to set inputs or outputs to a given state regardless of the program or input conditions. The programmer shall indicate power flow through all internal elements.

f. Programmable controllers' final documentation shall include an updated version of all items provided in the Submittals.

g. Programmable controllers shall be Allen-Bradley, no exceptions.

9. Electrical surge and transient protection.

    a. General: All control panels and field-mounted electrical and electronic components shall be equipped with suitable surge-arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges and nearby electrical devices.

    b. Suppressor Locations: Surge suppression equipment described herein shall be installed in the following locations:
        1) At the point of connection between each equipment item, including AC powered transmitters and its power supply conductors (direct-wired equipment).
        2) On all analog pairs at each end when the pair extends outside of a building.
        3) In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to the design of the equipment.

    c. Power Supply Suppressor Assemblies: Suppressors suitable for connection to 120-volt single-phase power supplies, shall be EDCO HSP121BT-1RU internal mount 120VAC protector or equal. Suppressors suitable for connection to 480-volt, 3-phase power supplies, shall be Square D J9200-9A or equal.

    d. Analog Signal Cable Suppressor Assemblies: Field mounted protectors for signal circuits shall be EDCO SLAC Series suppressor for 4-wire analog signals transmitters mounted in the field. EDOC Series SS64/SS65 for field mounted 2-wire analog signal transmitters. Suppressors shall be epoxy encapsulated within a phenolic enclosure. Suppressor assembly shall be flame retardant. Suppressor assemblies shall be four lead devices and shall include a threaded mounting/grounding stud. Inside control panels shall use EDCO Series DRS din rail panel mounted analog signal protector.

    e. Grounding: Surge suppressor grounding in field panels and field instrumentation shall be coordinated with Division 16, ELECTRICAL and suppressor manufacturer's requirements. Control panels shall be provided with an integral copper grounding bus for connection of suppressors and other required instrumentation.

10. Front-of-Panel Devices: The following devices shall be used in conjunction with NEMA I and NEMA 12 panels to provide conformity with Division 13, Instrumentation and Controls.

    a. Potentiometer: Units shall be three-terminal potentiometers. Units shall have oil-tight construction, resolution of 1 percent and linearity of plus or minus 5 percent. Units shall be single-hole, panel mounting accommodating panel thicknesses between (insert dimension) and ¼ inch. Units shall have legend plates with service markings. Units shall be Allen-Bradley, Model 800T; Cutler-Hammer, Model 10250T; or equal.

    b. Indicating Lights: Units shall be heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications. Units shall have screwed on prismatic glass lenses in colors noted, and shall have factory

engraved legend plates for service legend. Units shall be Cutler-Hammer Type 10250T; General Electric CR2940U; or equal.

c. Pushbutton, Momentary: Units shall be heavy-duty, oiltight, industrial type pushbuttons with momentary contacts rated for 10 amperes continuous at 120V ac. Button shall have full guard. Units shall have standard size legend plates with black field and white markings for service legend. Units shall be Square D, Class 9001, Type K, Cutler-Hammer, Type T; General Electric, Type CR-2940; or equal.

d. Selector Switch: Units shall be heavy-duty, oiltight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. Units shall have standard size, black field, legend plates with white markings, for service legend. Operators shall be black knob type. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-inch minimum to ¼-inch maximum. Units with up to four selection positions shall be Cutler-Hammer Type T, Square D Type K, or equal. Units with up to 12 selection positions shall be Rundel-Idec Standard Cam Switch, Electroswitch 31; or equal.

11. The following devices shall be used in conjunction with NEMA 4X panels to provide conformity with the plant instrument control system:

a. Potentiometer, Watertight: Units shall be three-terminal potentiometers. Units shall have heavy-duty watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent. Units shall be single-hole, panel mounting accommodating panel thicknesses between _ and ¼ inch. Units shall have engraved legend plates with service markings. The potentiometer shall have NEMA 4X construction. Unit shall be Allen-Bradley Bulletin 800H, or equal.

b. Indicating Lights, Watertight: Units shall be heavy-duty, push-to-test type, watertight, industrial type with integral transformer for 120V ac applications. The lights shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall have screwed on prismatic lenses, and shall have factory engraved legend plates for service legend. Units shall be Square D Type SK; Allen Bradley Type 800H; or equal.

c. Pushbutton, Momentary, Watertight: Units shall be heavy duty, watertight, industrial type pushbuttons with momentary contacts rated for 120V ac service at 10 amperes continuous. The pushbuttons shall be rated for NEMA 4X watertight, corrosion resistant service. Units shall have standard size, black field, legend plates with white markings for service legend. Button color shall be as noted. Units shall be Square D Type SK; Allen Bradley Type 800H; or equal.

d. Selector Switch, Watertight: 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 have standard size, black field, legend plates with white markings, for service legend. Operators shall be black knob type. Units shall have the number of positions and contact arrangements as noted. Units

shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to ¼-inch maximum. Units shall be Square D Class 9001, Type SK; Allen Bradley Type 800H; or equal.

G. Nameplates, Name Tags, and Service Legends:

1. All components provided with the package system, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped 316 stainless steel (22 gauge minimum thickness). Panel face mounted instrument name tags shall be mounted to the instrument behind the panel face.

2. Service legends (integrally mounted with instrument) and nameplates shall be engraved, rigid, laminated plastic type with adhesive back. Provide sufficient service legends and nameplates to adequately describe the functions of panel face mounted instruments. Color shall be white with black letters and letter height shall be 3/16 inch.

3. Each panel shall be provided with a face mounted laminated nameplate as specified above. Color shall be white with black letters ½-inch high.

H. Standard Light Colors and Inscriptions:

1. Unless otherwise noted in the individual Equipment Specifications, the following color code and inscriptions shall be followed for the lenses of all indicating lights:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	Blue
MANUAL	MANUAL	Green
LOCAL	LOCAL	Green
REMOTE	REMOTE	Blue

2. Lettering shall be black on white and amber lenses. Lettering shall be white on red, green, and blue lenses

I. Standard Pushbutton Colors and Inscriptions:

1. Unless otherwise noted in the individual Equipment Specifications the following color code and inscriptions shall be followed for all pushbuttons:

Tag	Inscription(s)	Color
OO	ON OFF	Black Red
OC	OPEN CLOSE	Black Black
SS	START STOP	Black Red
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

2. All unused or non-inscribed buttons shall be black. Lettering shall be black on white and yellow buttons. Lettering shall be white on black, red and green buttons.

2.5 SPARES, EXPENDABLES, AND TEST EQUIPMENT

Provide in sufficient quantity all spare material, expendable material, tools, test equipment, etc., necessary to maintain complete operation of the Control Systems for a minimum of one year. Items shall include the following:

A. Selector switch, pushbutton, and indicating light: 20 percent, one minimum, of each type used.

B. Light Bulb: 100 percent, two minimum, of each type used.

C. Fuse: 100 percent, two minimum, of each type used.

D. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 3 – EXECUTION

3.1 GENERAL

Install materials and equipment in a workmanlike manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

3.2 CORROSION PROTECTION

All control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through the use of corrosion-inhibiting vapor capsules. Prior to shipment, the capsules shall be provided within the shipping containers and equipment as recommended by the capsule manufacturer. During the construction period, the capsules shall be replaced periodically in accordance with the capsule manufacturer's recommendations. All capsules shall be replaced by the Contractor just prior to City's final acceptance of the equipment. The corrosion inhibiting vapor capsules shall be Hoffman Model A-HCI or equal.

3.3 CLEANING AND TOUCHUP PAINTING

Contractor shall keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of all devices and equipment. Touchup scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

3.4 PANELS AND PANEL MOUNTED EQUIPMENT

Panels and panel mounted equipment shall be assembled as far as possible at the Equipment Suppliers' plants. No work, other than correction of minor defects or minor transit damage, shall be done on the panels at the jobsite.

3.5 EQUIPMENT FURNISHED BY A SUPPLIER AND INSTALLED BY CONTRACTOR

Equipment Suppliers shall observe and advise on the installation to the extent required to certify in writing that the equipment will perform as required.

3.6 ELECTRICAL POWER AND SIGNAL WIRING

A. Control and signal wiring external to the control panels and all power wiring shall conform to the requirements of Division 16, ELECTRICAL.

B. Control and signal wiring in control panels shall be restrained by plastic ties or ducts. Hinge wiring shall be secured at each end so that any bending or twisting will be around the longitudinal axis of the wire and the bend area shall be protected with a sleeve.

C. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for any wire bundles which pass through holes or across edges of sheet metal.

D. Use manufacturer's recommended tool with the proper sized anvil for all crimp terminations. No more than two wires may be terminated in a single crimp lug and no more than two lugs may be installed on a single screw terminal.

E. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

3.7 INSPECTIONS

All materials, equipment, and workmanship shall be subject to inspection at any time by the Engineer. Correct any work, materials, or equipment not in accordance with these Contract Documents or found to be deficient or defective in a manner satisfactory to the Engineer at no additional cost to the City.

3.8 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be provided in accordance with the requirements of the specific equipment specification.

B. Tests:

1. Tests of the package control systems shall be in accordance with the individual equipment specifications.

2. As a minimum, the testing shall include factory tests. Prior to shipment, all panels and panel assemblies shall be tested for proper operation at the Equipment Supplier's factory.

END OF SECTION

SECTION 11512
SUBMERSIBLE RECESSED IMPELLER PUMPS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of submersible recessed impeller pumps complete and operational with motors, control equipment and 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. The contractor shall provide one shelf spare pump (total of nine submersible recessed impeller pumps to be provided).

2. 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. The manufacturer shall review the mechanical layout drawings and the available space at the site to familiarize themselves with the location and the setup of the equipment specified and shall assure themselves that the equipment proposed is appropriate for and coordinated with what is shown on the contract drawings and actual site conditions. The manufacturer shall also review the relevant electrical plan and one-line diagram and the relevant process and instrumentation diagram drawings to ensure that the proposed equipment is appropriate and coordinated with the equipment and controls specified and the monitoring and protection devices shown on the P&ID.

3. 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.

B. Type: Pump shall be heavy-duty submersible recessed impeller pump specifically designed for tough applications. Manufacturer shall include sparger rings for introducing fluidizing water at the pump suction. The sparger rings shall be designed to keep solids in suspension while keeping flows balanced in the vicinity of the impeller. Pump shall have large open passages for solids handling capabilities.

C. Related Work Specified Elsewhere:

a. Section 01600, General Material & Equipment Requirements

b. Section 01610, Transportation and Handling

c. Section 01650, Facility Startup

d. Section 05051, Anchor Systems

e. Section 11000, General Requirements for Equipment

f. Section 09900, Painting.

g. Section 16150, Electric Motors.

h. Section 16515, Adjustable Frequency, Controlled Speed, Drive Systems

i. Section 17100, Loop Descriptions

g. Section 17260, Process Control Panels and Hardware

D. Equipment Numbers: P3422, P3423, P3424, P3425, P3432, P3433, P3434, P3435, Spare

E. Performance Requirements:

1. The pumps shall perform in accordance with the following:

Performance Criteria:

Parameter	Condition A (Rated Condition)	Condition B
Capacity (gpm)	135	80
Total dynamic head (ft.)	38.5	26
Pump speed (rpm), maximum	1,600	
Pump efficiency (%), minimum	30	25
NPSHA (feet)	34.7	34.7
Motor Horsepower (hp), maximum	15	
Suction/discharge size (min., in.)	3.0/3.0	
Sparger Ring		
Flow range, (gpm)	10-30	
Number of nozzles	4	
Connection size, inch	1.25	

2. The pumps shall be specifically designed to pump wastewater and shall operate without clogging or fouling caused by material in the pumped fluid at any operating condition within the range of service specified. The pump and the driver shall be designed to operate at variable speed without cavitation or damaging vibration over the entire specified range of flow and head conditions. The pumping unit shall not be subject to or a source of undue noise, vibration, or undesirable conditions. The pump

head capacity curve shall slope in one continuous curve with no points of reverse slope inflection capable of causing hunting at any pump operational speed.

3. All components shall be designed to safely withstand forces resulting from flow reversals up to 125 percent of maximum speed within the pump during shutdowns caused by power failure.

4. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire operating curve.

F. Service Conditions: This is a “solid bearing liquids” abrasive service with solids consisting of fine sediment, grit and organic material. The fluid to be pumped is anticipated to range between 50 degrees F and 75 degrees F and to contain up to 3% of solids accumulated at the bottom of the sludge sumps. Equipment will be submerged in raw sewage containing abrasive inorganic solids and grit other solids. The equipment shall be suitable for long-term submersion and operation with the solids bearing fluid pumping service indicated above.

1.2 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. AFBMA 9 90, Load Ratings and Fatigue Life for Ball Bearings.

2. AFBMA 11 90, Load Ratings and Fatigue Life for Roller Bearings.

3. ASTM A48 83, Gray Iron Castings.

4. ASTM A108 90, Steel Bars, Carbon, Cold Finished, Standard Quality.

5. ASTM A276 90, Stainless and Heat Resisting Steel Bars and Shapes.

6. ASTM A278 85, Gray Iron Castings for Pressure Containing Parts for Temperatures of up to 6500 F.

7. ASTM A322 90, Steel Bars, Alloy, Standard Grades.

8. ASTM A576 90, Steel Bars, Carbon, Hot Wrought, Special Quality.

9. ASTM A743/A473M 89, Castings, Iron Chromium, Iron Chromium Nickel, Corrosion Resistances for General Applications.

10. ASTM A 532/A 532M, Specification for Abrasion-Resistant Cast Irons.

11. ASTM A 582/A 582M, Specification for Free-Machining Stainless Steel Bars.12.

12. Hydraulic Institute Standards, Standards of the Hydraulic Institute, 14th Edition.

13. Institute of Electrical and Electronic Engineers, (IEEE).
    a. IEEE 85, Airborne Sound Measurements - Rotating Electric Machinery.

14. National Electrical Code, (NEC).

15. National Electrical Manufacturers Association, (NEMA).

B. Warranty:

1. Contractor shall provide a two (2) year warranty against defective materials and workmanship commencing upon Owner's Acceptance. Warranty shall be in accordance with the General Conditions.

2. In addition, Contractor shall also provide the Owner with an extended limited warranty for the pump including impeller, motor, bearings, seals and the pump cable for performance of the pump equipment with respect to the specified performance criteria. The warranty shall bind the equipment manufacturer or the unit responsibility supplier for the equipment specified in this section and shall be backed by a performance and maintenance bond in the amount of 100 percent of the cost of the equipment. An irrevocable letter of credit, drawn on a U.S. government-insured banking institution, may be substituted for the specified bond. The warranty must be supplied to the Owner by the Contractor prior to start-up of the equipment and must be in a form acceptable to the Owner. The warranty shall be limited to all direct costs, including labor, and consequential costs relating to any required remedy, including replacement of the equipment, associated with failure of the equipment to perform as specified, consistent failure of the seals box, pump shaft or persistent failure of the pump bearings. The warranty shall cover the period during initial start-up and testing and from the date of expiration of the Contractor's standard one year warranty for a period of 365 days to allow for evaluation of equipment life and structural integrity over a period of 2 years.

C. Quality Standards:

1. Manufacturer shall have a minimum of five years of experience producing substantially similar equipment and shall provide evidence of at least five installations in satisfactory operation for at least five years.

2. The pumps shall be furnished by a single manufacturer who shall assume full 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.

2. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

3. The submersible recessed impeller pump manufacturer shall prepare all Shop Drawings and other submittals for all components furnished under this Section.

4. Manufacturers offering products that comply with these Specifications include:

   TOYO Pumps, Hazelton Pumps (Weir Minerals), Goulds Pumps, or equal modified as necessary to meet the requirements of this specification.

1.3 SUBMITTALS

A. A copy of the specification section in question, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (✓) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore, requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will denote compliance to the specifications. The submittal shall be accompanied with a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, shall be rejected with no further consideration.

B. A copy of any contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in the submitted section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.

C. Certificate of Unit Responsibility attesting that the Contractor has assigned unit responsibility in accordance with the requirements of this Section and Section 11000, paragraph 1.2 D. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

D. General arrangement drawings showing the equipment including minimum clearance distances around equipment required for maintenance and operations access. Include required height of each major component including the height taken up by recommended hoisting equipment. This shall include a materials list and descriptions of all major components and materials of construction for each component including catalog cuts, descriptive literature, and materials of construction.

E. Installation and wiring diagrams.

F. Complete description and sketch of proposed test setup for factory test. Submittal material shall include sample calculations and proposed test log format.

G. Predicted pump performance curves for each condition point showing head, power, efficiency and NPSH required on the ordinate plotted against capacity on the abscissa over the manufacturer’s recommended range of operation.

H. Proposed on-site testing and start-up procedures, including sketches and calculations for test as specified in paragraph 3.4.

I. Installation requirements, showing clearances required for maintenance purposes.

J. Detail drawings including plan views, elevation views and details, and descriptions of all items of equipment listed below but not limited to, showing all dimensions, parts, construction details.

K. Operation and Maintenance Manuals in accordance with General Conditions GC-28.

L. Detailed drawings of the control panel, wiring diagrams and dimensions identifying internal and face mounted components and connections to remote equipment.

M. Information and Motor Data Form in accordance with Section 01600 and Section 16150.

PART 2 – PRODUCTS

2.1 GENERAL

A. The sludge pump shall be located in the sludge sumps of sedimentation basins. The pump shall lift sludge (grit and solids) from the sump and pump to the existing sludge holding tank.

B. The pump shall be a submersible, recessed impeller type pump. The pumps will be operated with Variable Frequency Drives (VFD).

C. Pump manufacturer shall include a sparger ring that will be mounted to the floor of the sump. Sparger ring shall be of Type 316 stainless steel.

2.2 MATERIALS

Materials of construction shall be as follows:

Component	Material
Casing	Steel, 28% Chrome, ASTM A532
Impeller	Steel, 28% Chrome, ASTM A532
Shaft	Type 403 Stainless Steel, ASTM A582
Pump casing, motor housing, intermediate housing	Class 35B, grain cast iron, ASTM A48
Impeller	Steel, 28% High Chrome with minimum hardness of 600 BHN to handle abrasive materials, ASTM A532

Motor Housing	Class 30 Carbon Steel, ASTM A48
Pump base, discharge elbow	Class 35B grain cast iron, ASTM A48
Fasteners	Type 316 Stainless Steel, ASTM A193
Sparger ring	Type 316 Stainless Steel, ASTM A193

2.3 COMPONENTS

A. General:

1. Motor and rotating parts shall be removable from the motor end of the pump. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile O-rings. Pumps shall be fitted with dynamically balanced recessed impellers designed to pass coarse solids and stringy materials.

2. Pump shall be provided with 3-inch discharge piping connection. Pumps shall be permanently connected with stainless steel chain for easy removal and inspection from the sludge sump.

3. No portion of the pump casing or motor housing shall bear directly on the floor of the sump in the sludge sump.

B. Pump Shaft:

1. The motor/pump shaft will be a one piece heavy duty design manufactured in a Type 403 stainless steel material, which is resistant to corrosion from the intended pumpage. Static "O" ring seals will be fitted between the shaft and mechanical seals to ensure no leakage of the pumpage into motor housing. An adequate shoulder and locking arrangement will provide such that the thrust bearing is locked on the shaft.

2. The shaft shall not extend or overhang more than 2 1/2 times its diameter below the bottom support bearing. Certification by the manufacturer that this shaft limitation has been met shall be provided as product data.

C. Bearings:

The pump and motor shaft shall rotate on two sets of relubricatable ball bearings. The upper bearing, which will be located above the motor rotor, will comprise of a single row, deep groove ball bearing with a minimum B10 life of 50,000 hours at normal operating conditions. The lower bearing, which will be located below the motor rotor, shall comprise of two (2) single row angular contact bearings mounted in a back-to-back configuration and locked in place such that they accurately maintain the axial position of the shaft under normal or reverse thrust conditions. The thrust bearing will have a minimum B10 life at the normal operating conditions of 50,000 hours. The bearings will

be lubricated with a premium quality, long life, high temperature, lithium based synthetic oil grease.

D. Impeller:

1. Pump impeller shall be dynamically balanced, recessed type capable of handling solids, fibrous materials, heavy sludge and grit and other matter found in normal sewage applications. Impeller shall be constructed out of 28% Chrome alloy with the minimum hardness of 600 BHN to handle abrasive materials.

2. Fit between the impeller and the shaft shall be sliding fit with a tamper-lock bushing pressed by a screw which is threaded into the end of the shaft, or a slip fit onto the shaft and drive key and fastened to the shaft by an impeller nut having cover for protection from pumped fluid. The nut shall be of stainless steel material with minimum hardness of 350 BH.

3. The impeller shall be of the recessed type with heavy vane sections to resist erosion from abrasive solids carried by the pumpage. The impeller shall not contain any thrust balancing holes.

E. Mechanical seals:

1. Pump shall be provided with heavy-duty double 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. 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 the seal failure.

F. Cable 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.

G. Motor:

1. The pump motor shall be explosion proof, squirrel-cage induction, shell type design, housed in an air-filled or an oil-filled, watertight chamber, NEMA B type conforming to the requirements of Section 16150, Electric Motors. Motor shall be UL listed in accordance with UL 674 for Class I, Group D hazardous atmospheres. Motor shall be inverter duty.

2. 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 minimum of 10 starts per hour.

3. 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.

4. All electrical parts shall be housed in a watertight air filled cast iron enclosure. The mating parts of the motor assembly shall be manufactured using rabbet joints to ensure accurate location and sealed by the use of "O" rings. Electrical cables will be epoxy sealed and be attached to the motor housing. The motor shaft extension shall be stainless steel to resist corrosion form the liquid being pumped. All fasteners and nameplates will be of Type 316 stainless steel.

5. Provide three (3) thermal sensors embedded in the stator windings and wired to the pump VFD for motor thermal protection.

H. Exposed Surfaces:

All exposed nuts, bolts, and studs shall be AISI Type 316 stainless steel. All non stainless steel external metal surfaces coming in contact with the pumpage shall be protected by a suitable primer and epoxy finish coat.

2.4 ACCESSORIES

A. The pump manufacturer shall provide all submersible pumps with pump lifting chain, cable holder assemblies, safety chain hook assemblies, discharge elbow connections.

B. The sparger ring shall be supported from and anchored to the base of the sump. The sparger ring shall be provided with a flanged connection, for supply of plant water for fluidizing the

solids in the vicinity of the pump inlet. The sparger ring assembly shall be constructed of Type 316 stainless steel.

C. Davit Crane

1. One portable davit crane shall be provided for each sedimentation basin. One floor socket shall be provided for each pump. The submersible pump manufacturer shall provide the davit cranes.

2. The manufacturer has complete responsibility to ensure that the crane supplied shall be of adequate capacity and shall provide proper reach and lift distances to lift the pumps supplied, when located as shown on the Drawings. One electric operator, described at the end of this section, shall be provided. The crane shall be compatible with the electric operator.

3. Each assembly shall consist of a lifting davit, winch, and 316 stainless steel lifting cable. Length of cable shall be as required based on the Drawings and the equipment to be supplied. Cables shall be permanently attached to each pump and threaded into the hoist for removal. The lifting system shall be sized to provide a load safety factor of at least 3:1 in the crane system, and a load safety factor of at least 10:1 in the cable or chain components. Written certification from the manufacturer that the assembly complies with these requirements will be required.

4. The lifting davit assembly shall be constructed of 304 stainless steel, all other components shall be 316 stainless steel. It shall contain a lifting cable pulley assembly that is field adjustable to any location on the davit arm. This is to enable the lifting cable to be centered over the center of gravity of the pump regardless of its operating position and to avoid binding between the guides and rails. The winching system shall utilize a reversible ratcheting mechanism to allow safe, controlled raising and lowering of equipment. A maximum effort of 25 pounds force on the operating handle of the winch shall be required during manual operation.

5. The winch assembly shall also be easily field installed when needed. The hoists must allow 360 degrees rotation under maximum load by utilizing UHMW polyethylene or other suitable bearing material between bearing plates or flanges. Rotation within a floor-mounted socket will not be an acceptable system. A suitable handle shall be attached to the boom arm of the davit to assist in rotating the crane.

6. A separate socket shall be provided and installed at each pump location for use with the crane provided. The sockets shall be suitable for location inside the hatch openings. If the pump mount assembly includes provisions for use of the crane as a part of the assembly, the separate socket is not required.

7. A power assisted hoisting mechanism shall include a right angle drive electric drill and adapter for connection to the winch assembly. The drill shall be suitable for 120V, 1-phase, 60 hertz electric service, with 25 feet of power cable and plug.

8. Lifting equipment shall be load tested and certified in accordance with current OSHA standards.

D. Contractor shall provide Type 316 stainless steel anchor bolts for pump bases as recommended by the manufacturer.

2.5 SPARE PARTS

A. The following spare parts shall be provided for each pump.

1. Six (6) sets of all gaskets and O-rings.

2. Two (2) sets of pump bearings.

3. Two (2) mechanical seals.

B. Provide two (2) spare sparger ring assemblies.

2.6 FACTORY TESTS

Each pump shall be factory tested for performance and hydrostatic pressure as specified in the Hydraulic Institute Test Code. Test results shall be signed and certified by an officer of the manufacturing corporation.

2.7 PRODUCT DATA

The following information shall be provided in accordance with the general conditions and Section 01600:

A. Operation and maintenance information specified in General Conditions GC-28.6.

B. Electric motor manufacturer's standard overhaul instructions.

C. Manufacturer's Installation Certification Form 11000-A as specified in Part 3.

D. Manufacturer's Instruction Certification Form 11000-B specified in Part 3.

E. Field test results for each pump verifying specified flow rates as specified in Part 3.

PART 3 – EXECUTION

3.1 SHIPMENT, PROTECTION AND STORAGE

A. Equipment shall be shipped and stored in accordance with Section 01610.

B. Acceptance at Site: All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss

or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

3.2 INSTALLATION

A. Each pump shall be aligned, connected, and installed in accordance with the manufacturer's instructions and in accordance with Section 11005. The installation and initial operation shall be certified on Form 11000-A, specified in Section 01600.

B. Refer to the electrical drawings for the installation requirement that include Contractor provided terminal boxes for the transition from manufactures cables to specified wiring.

C. Paint equipment in accordance with Section 09900, Painting.

D. Prior to lowering of the pump in the sludge sump, pump shall be run dry to check the direction of the rotation. If the impeller rotates in the incorrect direction then pump motor leads shall be reversed to correct the problem.

3.3 FIELD TESTS

A. Testing of equipment and systems shall be conducted in accordance with the requirements of Section 01650 and Section 01600.

B. Demonstrate that piping connections to the pump nozzles are made with the pipe in a free supported state.

C. After installation of pumping equipment, give pump a running test in presence of Engineer to demonstrate its ability to operate without vibration or overheating, and to pump satisfactorily over the range and at the points specified. During tests, make observations of head, capacity, motor input, noise levels and vibration levels at pump. Correct or replace promptly defects or defective equipment revealed by or noted during tests at no expense to City, and if necessary, repeat tests until results acceptable to Engineer are obtained. Furnish labor, piping, equipment, and materials necessary for conducting tests.

   Test Duration. Determined by the Engineer or at minimum 24 hours.

D. Make all adjustments necessary to place equipment in satisfactory working order at time of above tests.

E. In the event that Contractor is unable to demonstrate to the satisfaction of Engineer that units will satisfactorily perform the service required, and that they will operate free from vibration and heating, the pumping units may be rejected. Contractor shall then remove and replace the equipment at his own expense.

3.4 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be provided in accordance with the requirements of Section 01640, Section 11000 General Requirements for equipment, and the following specific requirements.

B. A technically qualified manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum person-days listed for the services herein under, travel time excluded:

1. 1 man-day (minimum per pump) for installation assistance, inspection, certification and functional testing of the installation.

2. 1 man-day (minimum) for startup and operator training. Provide completed Form 11000-B Manufacturer’s Instruction Certification following the training.

END OF SECTION

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SECTION 11513

DOUBLE DISC PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install double disc sludge pumps complete and operational with motors, v-belt drive arrangement, control equipment and accessories. Anchor bolts are included in this Section.

B. Coordination:
1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the double disc sludge pumps Work.
2. Notify other contractors in advance of the installation of the double disc sludge pumps to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the double disc sludge pumps Work.

C. Related Sections:
1. Section 03300, Cast-In-Place Concrete.
2. Section 03600, Grout.
3. Section 05051, Anchor Systems.
4. Section 09900, Painting.
5. Division 15, Applicable Sections on Piping, Valves and Appurtenances.
6. Section 16150, Electric Motors.
7. Section 16515, Adjustable frequency, Controlled Speed, Drive Systems.
8. Division 17, Applicable Sections on Instrumentation and Controls.

1.2 REFERENCES

Standards referenced in this Section are listed below:
A. American Bearing Manufacturers Association, (ABMA).
B. American Gear Manufacturers Association, (AGMA).
C. American National Standards Institute, (ANSI).
D. ANSI Standards of the Hydraulic Institute, (ANSI/HI).
E. Institute of Electrical and Electronic Engineers, (IEEE).
IEEE 85, Airborne Sound Measurements - Rotating Electrical Machinery.
F. National Electrical Code, (NEC).
G. National Electrical Manufacturers Association, (NEMA).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
Manufacturer shall have a minimum of five years of experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Warranty:

1. Contractor shall provide a one year standard warranty in accordance with the General Conditions against defective equipment and poor workmanship.

2. In addition, Contractor shall also provide the Owner with an extended limited warranty for the pump including rotating parts, pistons, motor, and bearings, for performance of the equipment with respect to the specified performance criteria. The warranty shall bind the equipment manufacturer or the unit responsibility supplier for the equipment specified in this section and shall be backed by a performance and maintenance bond in the amount of 100 percent of the cost of the equipment. An irrevocable letter of credit, drawn on a U.S. government-insured banking institution, may be substituted for the specified bond. The warranty must be supplied to the Owner by the Contractor prior to start-up of the equipment and must be in a form acceptable to the Owner. The warranty shall be limited to all direct costs, including labor, and consequential costs relating to any required remedy, including replacement of the equipment, associated with failure of the equipment to perform as specified, or persistent failure of the pump components. The warranty shall cover the period during initial start-up and testing and from the date of expiration of the Contractor's standard one year warranty for a period of 365 days to allow for evaluation of equipment life and structural integrity over a period of 2 years.

C. Component Supply and Compatibility:
1. Obtain all equipment included in this Section regardless of the component manufacturer from a single double disc sludge pumps manufacturer.
2. The double disc sludge pumps equipment manufacturer shall review and approve or shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the double disc sludge pumps equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Complete layout and installation drawings showing mounting details, dimensions, weight, fitting locations, and materials of construction.

b. Wiring diagrams.
c. Drawings of control panels in accordance with Section 17000, General Requirements.

2. Product Data:
Complete product data, including manufacturer's brochure, specifications, complete parts list, performance data, turndown, and capacity.

3. Testing Plans:
a. Source quality control testing plan.
b. Field quality control testing plan.

B. Informational Submittals: Submit the following:
1. Certificates: Paint certification.
2. Manufacturer's Instructions:
a. Setting drawings, templates, and directions for installing anchor bolts and other anchorage devices.
b. Instructions for handling, storing, and installing equipment.
3. Source Quality Control Submittals: Results of source quality control tests and inspections.
4. Field Quality Control Submittals: Results of field quality control tests.
5. Manufacturer's Reports: Submit a written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained.
6. Qualifications Statements: When requested by ENGINEER, submit qualifications data for manufacturer.

C. Closeout Submittals: Submit the following:
1. Operations and Maintenance Data: Comply the City's General Conditions GC-28.
2. Spare Parts, Extra Stock Materials, and Tools: As specified in paragraph 2.5.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Description:
Pumps shall be double disc sludge type. Pumps will be operated with Variable Frequency Drives (VFDs), the VFD unit must be of constant torque design and if regeneration cannot be accounted for via programming a dynamic braking resistor will be required. Pumps shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:

B. Design Criteria:

Design Conditions	**82P3602, 82P3604**
Location:	Solids Processing Pump Station
Use:	Belt Filter Press Feed
Number Required:	2 (one duty/one standby)
Type:	Double Disc
Design Flow per Pump (gpm):	100 – 130
Design Head (ft):	10 – 85
Minimum NPSHa, (ft):	21.6
Motor, (Hp):	10
Motor Type:	Inverter ready
Disc Diameter, (in.):	15
Suction and Discharge Connections, (in.):	6
Liquid Pumped:	Thickened sludge
Maximum Solids, (percent):	5
Maximum Temperature, (ºF):	104
pH Range:	6-8
Maximum Pump Speed, (RPM):	150
Drive Type:	V-Belt and Pulley
Motor Enclosure	TEFC
Motor Electrical	460/3Ph/60 Hz

2.2 MANUFACTURERS

Manufacturers: Provide equipment of one of the following:
A. Penn Valley Pump Co., Inc.
B. Verder Pumps.
C. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:

1. Pumps shall be heavy-duty, double disc, positive displacement type. The pump shall consist of three (3) housings horizontally split to allow access to the internal components. The pump shall incorporate a repair-in-place hinged design that allows the pump to be serviced and discs replaced without removal of the pump or disturbing the suction and discharge piping. The discharge housing shall contain the mounting lugs and be bolted directly to the mounting frame. The discharge, intermediate and suction housings shall incorporate an integral hinge arrangement that allows the suction and intermediate housings to be lowered and removed. The hinges shall be connected to each other with a quick release ball detent pin allowing for easy pin removal.
2. The pump(s) shall be capable of providing the flowrate as shown in the pump schedule. The pumps shall be capable of operating dry for an indefinite period of time without damage. The pumps shall be capable of self-priming up to 14"Hg and 25"Hg when fully primed.
3. The pumping action shall be achieved by two (2) reciprocating discs attached to high tensile aluminum connecting rods driven by a rotating eccentric shaft. The suction and discharge discs shall be universal and interchangeable with each other to increase the commonality of spare parts and eliminate confusion. The discs shall be of integral design and constructed of high tensile neoprene with multiple layers of fabric for longevity and strength. Each disc shall be mounted to the connecting rod by a stub shaft constructed of hardened high tensile stainless steel. The reciprocating action of the discs shall also perform the duty of valves. Pumps that require internal check valves for operation shall not be acceptable.
4. Sealing of the pump fluid chamber shall be achieved by flexible trunnions. The trunnion construction shall be of fabric-reinforced neoprene and shall be capable of withstanding pressures from 0 to 110 PSI on an intermittent basis. Pump designs utilizing packing glands, mechanical seals or water seal systems will not be acceptable.
5. The swan neck entry port to the suction housing shall be a two (2) piece design allowing for mounting of the suction connection in 90 degree increments and provide easy access for clack valve replacement. The upper swan neck shall be provided with an NPT connection to allow mounting of the suction pulsation dampener if required. The entry port shall be the full pump size diameter to minimize debris buildup and blockages. The seating surface for the clack valve shall be machined on the mounting face of the swan neck. Designs that require an individual plate with smaller diameter opening shall not be acceptable. The clack valve shall be integrally mounted to the swan neck to facilitate access and replacement. The clack valve shall be manufactured of neoprene construction with multiple layers of fabric encapsulating a rigid core. The clack valve shall incorporate an integral O-ring seal for positive sealing.
6. The bearing drive assembly shall consist of two (2) aluminum modular pedestals designed to provide accurate bearing alignment, superior bearing loading and ease of assembly. The drive shaft shall be capable of withstanding a dead head situation. The shaft shall be constructed of hardened high-tensile stainless steel and shall be mounted on four (4) self-aligning, sealed bearings.

The eccentric cams shall be constructed of high tensile, cast bronze alloy and shall be pinned to the shaft by spiral drive pins to allow for the absorption of reciprocating loads generated by the pumping action. Pump drive assemblies that utilize keyways and setscrews will not be acceptable. All drive bearings must be completely sealed with no provisions for scheduled grease lubrication. No grease fittings shall be supplied for the bearings.

7. The pump shall be driven through a V-belt drive assembly consisting of 2 groove Type B sheaves with belts selected for the power required. The pulley ratios shall be sized to provide the maximum pump speed listed in the pump schedule in this section and to provide the required torque generated between the pump and motor.
8. Motor shall be piggy-back-mounted.
9. Pump shall be provided with OSHA approved guards and covers. The V-belt drive cover and pump drive assembly cover shall be manufactured from SS304 material.
10. Each pump and drive assembly shall be mounted on a common SS304 sub base. Base design shall have raised cross-members on the suction and discharge end to allow for complete wash-out and draining without trapping liquid. Each sub base shall be manufactured from SS304 square tubing. Base shall be sufficiently gusseted, reinforced and braced to withstand all shock loads and resist all wearing and buckling during pump operation. Tubing ends shall be capped with black plastic plugs for neat appearance.
10. Pulsation dampeners shall be provided on both the suction and discharge. The dampeners shall be SCH 40 carbon steel pipe with fully welded end caps. The suction dampener shall mount directly to the suction swan neck through the NPT connection. The discharge dampener shall be provided with ASA 150# flanged connections. The dampeners shall be pressure tested to 100 psi for leaks. Each dampener shall be provided with a 1-inch half coupling located at the top. This connection shall be suitable for the vacuum and pressure switch assembly or the ball valve/quick disconnect assembly should a switch not be specified. The discharge dampener shall be supplied with a 1 ½" NPT coupling and plug in the bottom to act as a drain/sample port. Bladder type and three-piece pulsation dampener assemblies using connecting rods and gasket shall not be acceptable.
11. Anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations. The anchor bolts shall be Type 316 stainless steel and shall conform to the requirements of Section 05051, Anchor Bolts, Toggle Bolts and Concrete Inserts.
12. All bolts, nuts and cap screws shall have hexagon heads.
13. A stainless steel nameplate giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.

B. Motor:

The motor shall be adequately sized to withstand the loads during starting and pump operation. The horsepower and motor speeds shall conform to the specifications as outlined in the pump schedule. Motor shall be Baldor-Reliance Super-E Severe

Duty, premium efficient, inverter ready per NEMA STD MG1 Part 31.4.4.2 with epoxy coated cast iron frame or equal.

C. Suction Vacuum Protection:
The pump manufacturer shall provide a suction vacuum sensor and switch assembly to mount on the suction pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360-degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with SS316 fittings. The vacuum assembly shall be fitted with 4" stainless steel 30"Hg – 30 psi gauge and Ashcroft, Barksdale, or equal adjustable vacuum switch set at 10"Hg. The units shall be capable of being cleaned in place by simply using the process pressure through a SS316 isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

D. Discharge Pressure Protection:
The pump manufacturer shall provide a discharge pressure sensor and switch assembly to mount on the discharge pulsation dampener. The sensor shall be a PVP420, Red Valve 42/742 or equal 1-inch NPT isolation pressure sensor with SS316 body and EPDM elastomeric sensing tube. The process pressure is sensed through the 360- degree elastomeric tube and glycerin transfers pressure to the gauge and switch. The gauge and switch shall be attached to the sensor with SS316 fittings. The discharge assembly shall be fitted with a 4" stainless steel 0-60 psi pressure gauge and shall be fitted with Ashcroft, Barksdale, or equal, adjustable switch preset at 10 psi above max operating pressure. The units shall be capable of being cleaned in place by simply using the process pressure through a SS316 isolation valve mounted to the top of the sensor. The opposite end of the valve shall be fitted with a universal, quick acting coupling, suitable for compressed air. This valve connection will be suitable to charge the dampener with compressed air.

2.4 TOOLS AND SPARE PARTS

A. Provide the following factory recommended spare parts, one (1) set for each size pump specified:
   1. Two (2) Double Discs
   2. Two (2) Trunnions
   3. Two (2) Complete set of gaskets
   4. One (1) Clack valve

B. No special tools shall be required for disassembly, maintenance or repair.

C. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

2.5 SURFACE PREPARATION AND PAINTING

A. Pumps, motors, drives, frames, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09900, Painting.

B. Surface preparation and painting shall conform to the requirements of Section 09900, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. CONTRACTOR shall certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09900, Painting.

2.6 SOURCE QUALITY CONTROL

A. Furnish labor, piping, equipment and material for conducting the tests.

B. Give each pump a running test in the presence of ENGINEER demonstrating its ability to operate without vibration or overheating and deliver its rated capacity under specified conditions. Specifically the following items shall be measured at five (5) points over the entire operating range:
   1. Discharge Head
   2. Suction Head
   3. Capacity
   4. Pump Speed
   5. Amperage draw

C. Correct all defects or replace defective equipment, revealed and noted during tests. Make necessary adjustments at the time of tests at the expense of contractor.

D. Repeat tests if necessary to obtain results acceptable to ENGINEER.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

3.2 INSTALLATION

Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the OWNER'S satisfaction.

3.3 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.

B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. As described under Section 01650, Facility Startup, the representative shall make the minimum number of visits for assistance in the installation of equipment and checking the completed installation and start-up of the system. Each visit shall be for the minimum duration specified. As described under Section 01664, Training, the representative shall make the number of visits required to meet the minimum training durations.

C. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR’s bid price.

END OF SECTION

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SECTION 11520
CIRCULAR GRAVITY THICKENER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install new circular gravity thickening equipment in the existing sludge holding tank complete and operational.
   2. Included, but not limited to, are the following components for each unit:
      a. Bridge and walkway with handrails and toeplates.
      b. Support column, center cage, sludge rake arms with plows and pickets
      c. Center drive mechanism.
      d. Local Control Station.
      e. Anchor bolts.
      f. Weir plate.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the circular thickening equipment Work.
   2. Notify other contractors in advance of the installation of the circular thickening equipment to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the circular thickening equipment Work.

C. Related Sections:
   1. Section 03300, Cast-In-Place Concrete.
   2. Section 03600, Grout.
   3. Section 05051, Anchor Systems.
   4. Section 05120, Structural Steel.
   5. Section 05500, Miscellaneous Metals.
   6. Section 05524, Component Aluminum Handrails.
   7. Section 09900, Painting. (Specifications for surface preparation and shop priming required under Section 11520, Circular Gravity Thickener, are specified under Section 09900, Painting.)
   8. Section 16150, Electrical Motors.
   9. Section 17000, Instrumentation, Control and Monitoring System General Requirements
   10. Section 17260, Process Control Panels and Hardware.
   11. Section 17275, Miscellaneous Panel Instruments.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers' Association, (ABMA).
   2. American Gear Manufacturers' Association, (AGMA).
      a. AGMA 240.01, Gear Materials Manual.
      b. AGMA 908, Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth.
      c. AGMA 2001, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
      d. AGMA 2004, Gear Materials and Heat Treatment Manual.
      e. AGMA 6034, Practice For Enclosed Cylindrical Worm Gear Speed Reducers and Gear Motors.
   3. American Institute of Steel Construction, Inc., (AISC).
      a. AISC 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. AISC S326, Design, Fabrication and Erection, Structural Steel.
   4. American Society for Testing and Materials, (ASTM).
      a. ASTM A 36/A 36M, Specification for Carbon Structural Steel.
      b. ASTM A 48/A 48M, Specification for Grey Iron Castings.
      c. ASTM A 193/A 193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
      d. ASTM A 307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      e. ASTM B 209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      f. ASTM B 429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
      g. ASTM B 782, Specification for Iron Graphite Sintered Bearings (Oil-Impregrated).
   5. American Welding Society, (AWS).
      AWS D1.1/D1.1M, Structural Welding Code-Steel.
   6. Institute of Electrical and Electronics Engineers, (IEEE).
   7. National Electrical Code, (NEC).
   8. National Electrical Manufacturers' Association, (NEMA).
   9. National Fire Protection Association, (NFPA).
      NFPA 79, Electrical Standard for Industrial Machinery.
   10. National Sanitation Foundation, (NSF).
   11. The Society for Protective Coatings, (SSPC).
   12. International Building Code, (IBC).

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:
   Manufacturer shall have a minimum of five years’ experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years. Equipment manufacturer

shall be original equipment manufacturer of the thickener drive mechanism.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single circular thickening equipment manufacturer.
   2. The circular thickening equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the circular thickening equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: in addition to the requirements of General Conditions requirements, submit the following:
   1. Shop Drawings:
      a. Drawings showing all dimensions, weights, materials of construction, structural members, sludge collection members, welds, torque ratings, and gears.
      b. Fabrication methods, assembly, accessories, installation details, grouting plans, and wiring diagrams.
      c. Submit setting drawings, templates, and directions for the installation of anchor bolts and other anchorages. Location, number, type, and proposed embedment of epoxy adhesive anchors to be used for the torque test specified herein.
      d. Drawings and information for control panels and instruments, including complete control panel details, wiring diagrams showing all electrical connections to motors and Variable Frequency Drive (VFD), logic diagrams, and detailed specifications conforming to this Section, Section 17000, Instrumentation, Control and Monitoring System General Requirements, Section 17260, Process Control Panels and Hardware, and Section 17275, Miscellaneous Panel Instruments. This includes submittal of panel wiring drawings, hardware, circuit breakers, VFD, and electrical devices furnished.
   2. Product Data:
      a. Manufacturer's literature, illustrations, specifications and engineering data.
      b. A certified motor data sheet for each type and size of motor. The data sheet shall show winding resistances; torques; guaranteed minimum efficiencies at full, 3/4 and 1/2 load; power factors; slip; full load, locked rotor and running light amperes; temperature rise and results of dielectric tests. All values shall be from tests of the job motor or previously manufactured electrically duplicate motor. Data sheets shall be marked to indicate motor application, manufacturer, type, frame size, bearing type, lubrication medium, insulation type, and enclosure type.
      c. Deviations from the Contract Documents.

d. Include the following product data on the Shop Drawings:
   1) Torque at which collector will stall.
   2) Torque at which collector high torque warning and shutdown alarm is set.
   3) Torque at which collector is designed to operate continuously.
   4) Speed of collector rotation.
   5) Direction of collector rotation.
   6) Loads for which center pier foundation should be designed.
   7) Loads for which wall at center pier foundation should be designed.
   8) Type, specifications, detail drawings and information on type, input and output speeds, exact gear ratios, service factor (24-hour continuous service), capacity, and efficiency of gear reducer units, and drive assembly, and diameter of ball race.

e. Control system data including the following:
   1) Detailed product information on the control system instruments, components and control devices.
   2) Control system panel construction and layout drawings including locations of external wiring and piping connections, mounting and installation details, wiring diagrams, schematics, and all electrical connections.
   3) Electrical control schematics in accordance with NFPA Annex "D" Standards.
   4) Details and descriptions of the overload protection assembly. Details submitted shall clearly demonstrate the adequacy of the overload protection provided by the assembly proposed. Overload alarm contact shall be provided as shown on the control diagram.

f. Lubricant Specification: Furnish a lubricant specification for the type and grade necessary to meet the requirements of the equipment.

3. Delegated Design Data:
   a. Structural design and analysis of the sludge collection mechanism performed and certified by a Registered Professional Engineer. The structural analysis shall be submitted with sufficient detail to demonstrate conformance to the Contract Documents.
   b. Calculations based on AGMA standards for spur and pinion gear durability and strength, to verify compliance with a continuous 20 year torque rating.

4. A list of the three most recent installations, where similar equipment by the MANUFACTURER is currently in service, including contact name, telephone number, and address.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      Submit results of routine factory motor tests.
   2. Site Quality Control Submittals:
      a. Manufacturer’s Certificate of Proper Installation
      b. Submit a written report providing the results of the required field tests.
   3. Special shipping, storage and protection, and handling instructions.

C. Closeout Submittals: Submit the following:
Operation and Maintenance Manuals:

1. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
2. Furnish Operation and Maintenance Manuals in conformance with the requirements of General Conditions GC-28Working Drawings, Shop Drawings, Data on Material and Equipment, Samples, and Licenses.

D. Maintenance Material Submittals: Furnish the following:

1. Spare Parts:
   List of suggested spare parts to maintain the equipment in service for a period of 5 years.
2. Tools:
   Furnish all required special tools as specified in Part 2 of this specification. Such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

1.6 WARRANTY

A. A written suppliers warranty shall be provided for the equipment specified in this section as required in the General Conditions GC-22.
B. CONTRACTOR shall obtain from the equipment SUPPLIER/MANUFACTURER warranty for all material, equipment, and appurtenances specified in this section. The warranty shall be for a minimum period of five (5) years from start-up or 66 months from time of equipment shipment, whichever comes first. Equipment warranty shall cover all failures of material or workmanship which occur as the result of normal

operation and service.

C. MANUFACTURER shall certify that replacement parts can be delivered within 7 days.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

Description:

Circular thickening equipment shall be suitable for collecting and removing thickened sludge as specified herein. Equipment shall be of a heavy duty cage drive mechanism type with all components oversized including an oversized drive for extreme high torque capabilities. The entire structure and mechanism, including center support for the walkway, shall be supported on the center column. The center driving mechanism shall rotate a suspended center cage with rake arms attached at a speed suitable for the material to be collected. The feedwell shall be supported from the service bridge and shall remain stationary.

2.2 DESIGN CRITERIA

Service Conditions:

A. Number of Thickeners: 1.
B. Material Collected and Removed: combined sewer overflow thickened primary sludge.
C. Inside Thickener Diameter: 86 ft.
D. Side Water Depth: 15 ft.
E. Freeboard: 1 ft.
F. Tank Bottom Slope: 1:12.
G. Design Flows to Sludge Holding Tank: 683,000 gpd.
H. Dry Solids Loading to Thickeners: 28,490 lbs/day.
I. Surface Overflow Rate: 118 gpd/sf ft.
J. Collector Tip speed: 5-15 fpm,
K. Minimum turndown of the rake speed: VFD controlled by operator

2.3 MANUFACTURERS

Manufacturers: Provide equipment of one of the following:

A. WesTech.
B. Walker Process Equipment.
C. Ovivo.
D. Envirodyne Systems, Inc.
E. Or equal.

2.4 DETAILS OF CONSTRUCTION

A. General:
   1. Corresponding parts of multiple units shall be interchangeable.

2. No chains or sprockets shall be below the liquid surface or in contact with the liquid.
3. Design of the center mechanism and drive unit shall permit continuous operation at the continuous torque rating without excessive wear and shall permit development of the maximum operating torque without damage to or failure of the mechanism and drive components.

B. Materials:
1. Structural steel shall be ASTM A 36/A 36M and shall conform to requirements of AISC "Design, Fabrication and Erection, Structural Steel." Maximum allowable stresses on structural steel under continuous operating torque loading shall not exceed those permitted in the AISC specifications.
2. Welding shall conform to the requirements of AWS D1.1/D1.1M.
3. Except where otherwise specified to be stainless steel, bolts and fasteners shall conform to ASTM A 307. Stainless steel shall be series 300, Type 316 stainless steel.
4. Unless otherwise shown or specified all steel shall have a minimum thickness of 1/4-inch and all bolts a minimum diameter of 1/2-inch.
5. Gears used in the center mechanism and drive shall conform to standards as follows:
   a. Spur Gears: AGMA 2001.
   b. Worm Gears: AGMA 6034.
6. Iron castings, where used, shall conform to ASTM A 48/A 48M.
7. Precision bearings shall have an L 10 life of 100 years or 876,000 hours, except pinion shaft lower bearing, if required, and the bearing on worm shaft drive end which shall have a minimum life of 100,000 hours.
8. If worm gears or spur gears are utilized they should incorporate a minimum 2.5 service factor.

C. Center Support Column:
1. Minimum Criteria:
   a. New center column to be installed in the existing sludge hopper. Contractor to ensure that the new column fits in the existing structure.
   b. Diameter: 30-inch diameter.
   c. Minimum Welded Steel Plate Thickness: 3/8-inch.
2. Provide bottom 1” minimum flange for bolting to concrete in the existing sludge hopper and a heavy mounting plate at top to support center drive mechanism.
3. Design column for maximum possible torque, and impact capable of being developed by drive mechanism plus weight of mechanism and one end of walkway.
4. Provide bottom flange for bolting to concrete with a minimum of twelve 1-1/4inch diameter, or as recommended by the manufacturer, Type 316 stainless steel anchor bolts. Provide a heavy mounting plate at top to support center drive mechanism and set plumb with the centerline.

5. Design column for maximum possible torque, and impact capable of being developed by drive mechanism plus weight of mechanism and walkway.

D. Center Cage:
   1. Provide center cage of steel truss construction designed to support and rotate the rake arms. Minimum steel thickness shall be 1/4-inch.
   2. Bolt center cage to center drive mechanism which shall rotate center cage and attached rake arms.

E. Feedwell:
   1. Provide steel feedwell concentric with center column, supported by service bridge. Top edges shall be approximately 6-inches above tank maximum water surface. Feedwell to include an 8" stub pipe with flanges on both ends to accommodate the influent pipe and tee.

   2. Minimum dimensions:
      a. Diameter: 16-feet.
      b. Height: 5 feet (4.5-feet water depth, plus an additional 6-inches minimum freeboard).
      c. Minimum steel plate thickness: 1/4-inch.

G. Rotating Rake Arms:
   1. Provide two rotating rake arms conforming to slope of tank floor and consisting of structural steel triangular or box trusses attached rigidly to the center cage.
   2. Arms shall be self-supporting and without tie rods. Provide adjustable bolts at top chord and heavy pins and yoke at bottom chord for vertical adjustment.
   3. Provide each arm with 9" minimum deep segmented rake blades with Type 304 stainless steel squeegees. Squeegees shall be slotted for 2-inch vertical adjustment. Segmented rake blades shall be identical for each arm with the placement such that entire tank bottom is scraped twice for each revolution.
   4. Each rake arm shall be designed for its own dead load plus 120 percent of its proportional share of the design total torque.
   5. The horizontal and vertical deflection at the ends of the rake arms shall not exceed the length of the arm divided by 1,000, even when the distribution of the design total torque is unequal at maximum distribution ratio of 60:40.
   6. The scraper flights shall scrape the sludge to an annular trench at the center of the tank. Provide scraper blades in the annular trench from each arm to prevent compaction of sludge in the trench and to move sludge to the sludge outlet pipe.
   7. Provide vertical pickets spaced every 2', on the rake arms to aid in thickening of the sludge. The height of the pickets to be within 1' of the influent pipe closest to the tank wall. The pickets shall be 3" wide.

H. Bridge and Walkway:
   1. New bridge to be installed in the existing bridge notches.

2. Provide bridge and walkway assembly constructed of two structural trusses 42-inches minimum height or beams spanning from the tank wall to the center access platform.
3. Walkway shall be 36-inches width to fit in the existing structure, constructed of 1-1/4-inch non-slip aluminum grating. Supply a center access platform to provide a minimum of 3' clearance around the drive mechanism.
4. Provide aluminum handrails system with a aluminum toe plate on both sides of walkway and completely around the center platform. The handrails shall conform to the requirements of the drawings and Section 05524, Component Aluminum Handrails. Walkway trusses, where used, may be incorporated as part of this railing, providing they conform to requirements of Section 05500, Miscellaneous Metals, and Section 05120, Structural Steel.
5. Bridge shall be designed to support dead loads plus a minimum walkway live load of 100 pounds per square foot with a deflection not to exceed 1/360 of the span.

I. Center Drive Mechanism:
1. Provide center drive mechanism mounted on center column with leveling bolts. It shall consist of turntable base with ball race, spur gear, gear motor and drive unit.
2. Design mechanism and platform for ready access for maintenance without disturbing walkway.
3. Turntable base shall be high tensile, 40,000 psi cast-iron orcast steel, with annular raceway for a ball race near outer periphery. The oil reservoir shall allow for 100% bearing submergence in oil at all times. Designs that rely on "splash lubrication" for any part of the bearing lubrication are not acceptable. It is the intent that the bearings will remain in a 100% oil bath even when not in service to prevent possibility of corrosion. The reservoir shall be protected by both a neoprene seal and a dust tight shield. Provide oil sight glass.
4. Gears shall have minimum Brinnel 300 hardness. Spur gear shall be rotated by a separately mounted spur pinion keyed to gear reduction unit. Gearing shall be designed and rated using the criteria established by the American Gear Manufacturers Association (AGMA) standards.
5. Pinions shall have a minimum Rockwell hardness of C55 with minimum through hardness of Brinnel 300.
6. Drives shall have a minimum design life of 20 years based on moderate shock loading for 365-days, 24-hours, of continuous operation at the rated speed and continuous torque rating.
7. Drive Unit:
    a. Provide precision bearing center drive mechanism mounted on center column with leveling bolts. It shall consist of turntable base with ball race, spur gear, gear motor and drive unit. Design the drive to meet both continuous operating torque and overturning moment. Strip liner bearings are not acceptable and will not be approved.
    b. Gear head shall have AGMA Class II rating and AGMA rating plate shall be fastened to unit.

c. VFD rated motor, with the single 60 inch pinion ductile iron spur gear, 19" intermediate worm gear with worm shaft actuated overload indicator and shear pin coupling, shall be totally enclosed, fan cooled, chemical service type, suitable for outdoor operation. Motors shall conform to the requirements of Section 16150, Electric Motors.
d. Motor shall be suitable for operation on 230/460 volt, 3 phase, 60 Hz power.
e. Motor shall be of adequate size so that there is no overload on the motor above rated nameplate horsepower under normal conditions of service, but not less than 2 horsepower.
f. Provide space heaters, 120 volt, single phase.
g. Motor shall have a 1.25 service factor, and shall comply with the latest ANSI, NEMA, ABMA and IEEE Standards as a minimum.
h. Locked rotor current shall be as specified in NEMA standards.
i. Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of service, and shall have a minimum B-10 life of 100,000 hours.
j. Provide motor thermal protection in the form of a thermal switch with temperature protection range adequate to the manufacturer recommended maximum winding temperature for the motor. Provide shop drawing submittal for approval.
k. Motor shall have a stainless steel nameplate which shall provide the following: Type, frame, insulation, class, HP, full load current, RPM, centigrade degree rise, manufacturer's name and serial number, model number, voltage, locked rotor KVA code, bearing numbers and a connection diagram.
l. Motor terminal boxes shall be oversized to provide adequate space for connections and shall be constructed of cast-iron or fabricated steel, neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.

8. Design drive assembly for the following torques:
a. Continuous operating torque: 130,000 ft-lbs.
b. Momentary peak torque: 296,000 ft-lbs.
c. Alarm torque: 100% of scale.
d. Shut-down torque: 110% of scale.
e. Second cut-out (shear pin): 140% of scale.
f. Field Test Torque: 140% of scale.

J. Weir Plates:
1. Provide effluent weir plates of 1/8-inch by 9-inch Type 304 stainless steel, secured to the effluent weir trough. The weir plate shall have V-notches and shall use butt plates at the joints. Neoprene gaskets shall be provided where shown or required. Fabricate plates to allow minimum adjustment of (±) one-inch.
2. All bolts and nuts shall be of Type 316 stainless steel.

2.5 FABRICATION AND MANUFACTURE

A. Fabricate in sections as large as truck or rail shipment permit.

B. Assemble equipment for each tank in the shop. Match mark it with erection marks before it is dismantled for shipment.

2.6 CONTROLS

A. Overload Protection Systems:
Mechanically Actuated Overload System: The system shall include two electrical relays with normally open contacts for audio and visual alarm at the Local Control Station (LCS), remote notification to the SCADA system and to cut out the motor at shut-down torque. A third backup switch for motor cutout or shear pin. An overload release clutch, as manufactured by the Centric Clutch Company; or equal, will be acceptable as an overload protective device. A separate indicating device suitable for outdoor mounting shall be provided to indicate mechanism loading at all times during operation.

B. Local Control Station (LCS):
1. The Thickener manufacturer shall provide a NEMA 4X, 316L type stainless steel LCS to control and protect the Thickener mechanism and shall conform to the applicable requirements of Section 17260, Process Control Panels and Hardware and Section 17275, Miscellaneous Panel Instruments. The control panel shall be built in a UL508A/698 certified panel shop.

2. The LCS shall be mounted on the central platform and supported with Type 304 stainless steel members suitably designed for the panel loads. The control panel positioning shall not interfere with personnel access to the thickener drive mechanism.

3. All conduit and wiring between the Thickener LCS, drive torque monitor, power distribution system, VFD and the SCADA system shall be provided and installed by the electrical contractor.

4. The LCS shall be provided with the following devices mounted on the exterior of the enclosure:
   a. Top mounted amber strobing alarm light.
   b. Door mounted red running light.
   c. Door mounted amber VFD fault light.
   d. Door mounted amber high torque warning light.
   e. Door mounted amber torque cutout light.
   f. Door mounted amber Overload.
   g. Door mounted amber high winding temperature.
   h. Door mounted HOR position selector switch.
   i. Door mounted alarm silence pushbutton.
   j. Door mounted reset pushbutton.
   k. Door mounted speed potentiometer.

l. Door mounted Speed feedback indication.
m. Door mounted start and stop pushbuttons.
n. Door mounted emergency stop mushroom pushbutton.

5. The following signals shall be made available as dry contacts for remote monitoring by the plant SCADA:
   a. Drive running status.
   b. Drive VFD fault.
   c. High torque alarm.
   d. Cutout torque alarm.
   e. Overload.
   f. High Winding temperature.
   g. Drive in remote
   h. E-stop

6. The following signals shall be made available as 4-20 mA signal for remote monitoring by the plant SCADA:
   Speed feedback

7. The following control signals shall be made available for remote control from the plant SCADA:
   a. Start/Stop (dry contact)
   b. Speed Command (4-20 mA)

8. Workmanship shall be of the highest quality with all wiring on the enclosure back panel routed through plastic wire way and all door routed wire securely fastened with adhesive feet and nylon ty-wraps. Wires that cross enclosure hinges shall be protected with nylon spiral wrap and must have adequate slack to allow the door to open 180 degrees. All components on the back panel shall be mounted using a minimum size #14 machine screws. Rivets and self-tapping screws are not acceptable.

2.7 SPARE PARTS

A. Furnish and deliver the following spare parts:
   1. One set Type 304 stainless steel squeegees.
   2. One set of all seals.
   3. One chain sprocket (if used).
   4. One steel drive chain (if used).
   5. Twelve shear pins (if used).
   6. Six sets of shear pin thimbles (if used).

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of five (5) years. The list shall describe each part, the quantity recommended, and the unit price of the part. OWNER will purchase all, some, or none of the recommended parts at his option.

2.8 PAINTING

A. Surface preparation and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09900, Painting.

B. Coat bearing, gear and similar machined, polished and non-ferrous surfaces with corrosion prevention compound which shall be maintained during storage and until equipment begins operation.

C. CONTRACTOR shall certify, in writing, that the shop primer and finish coating system conforms to the requirements of Section 09900, Painting.

D. Field painting shall conform to the requirements of Section 09900, Painting.

E. Photo documentation that paint coats are applied to the interior of the center support column prior to installation.

2.9 ANCHOR BOLTS

Furnish anchor bolts and nuts of Type 316 stainless steel, of ample size and strength for the purpose intended, sized by the equipment manufacturer. Anchor bolts shall be stainless steel adhesive anchors, and provided for direct embedment per Manufacturer's recommendations. Adhesive anchors shall conform to the requirements of Section 05051, Anchor Systems.

2.10 SOURCE QUALITY CONTROL

Running Test: Prior to shipment, operate each gear reducer at normal operating speed using a rust inhibiting break-in oil to check for proper operation, excessive noise and vibration. Operate each gear reducer for a period of one hour. Submit letter to ENGINEER with each packing slip certifying the gear reducer has been operated and that it has operated without excessive noise and vibration.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall field verify existing structure conditions and dimensions prior to approval of Shop Drawings.
B. Install in accordance with manufacturer's written instructions.
C. CONTRACTOR shall examine the conditions under which the Work is to be

installed and notify the ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

D. Make adjustments required to place system in proper operating condition.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation before operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the OWNER'S satisfaction.

B. CONTRACTOR shall furnish and install all required oil and grease for initial operation per manufacturer's specifications.

C. Concrete Floor Topping:
   1. Place 2-inches of grout topping on the tank bottom. Topping shall be as shown, described herein and as specified under Division 03, Concrete Work.
   2. Equipment installation shall be complete and accurately adjusted by a manufacturer's representative prior to placing the topping. Manufacturer's representative shall be present during topping installation.
   3. Check topping for correct placement by using the rake arms as a guide only. Driving mechanism shall not be used to power rake arms during the screeding and arms shall not be used to scrape or level the ground.
   4. Do not use collector drive mechanism to place and spread grout.
   5. Grout topping shall be placed in strict accordance with circular thickening mechanism manufacturer's directions and under its supervision.

D. After setting and adjustments are completed check weir plates with reference to liquid level in full tank. Make any adjustments required so that all weirs are at equal elevation.

3.3 FIELD TESTS

A. After CONTRACTOR and ENGINEER have mutually agreed that the equipment installation is complete CONTRACTOR and a qualified field service representative of the manufacturer shall conduct a running test and a torque test in the presence of ENGINEER to demonstrate that the mechanism and its controls will function correctly and that it is structurally sound.
   1. Running Tests:
      All gravity thickener units together with their controls shall be field tested. Tests shall demonstrate to ENGINEER that each part and all parts together function in the manner intended. All necessary testing equipment, materials and manpower shall be provided by CONTRACTOR.
   2. Torque Test:
      a. The torque test shall consist of securing the rake arms by cables to anchor bolts installed by CONTRACTOR in the tank floor at locations recommended by the manufacturer and accepted by ENGINEER.

b. A torque load shall be applied to the truss arms by means of a ratchet level and hydraulic cylinder connected to the cable assembly. The magnitude of the applied load shall be measured by calibrated pressure reading, the plunger and rod area, and the distance of the line of action of each cylinder from the centerline of the mechanism.
c. Readings shall be taken at 50 percent, 75 percent, 110 percent, and 125 percent of continuous running torque value.
d. The test load shall be applied such that the torque overload device can be used to indicate and signal the alarm and motor cutout torque values of the drives.
e. Loads shall not be applied by turning on the motor.

3. In the event that the manufacturer is unable to demonstrate that equipment meets the requirements of the tests, CONTRACTOR shall adjust, modify and retest the equipment as often as necessary in order to meet the specified requirements.

3.4 MANUFACTURER'S SERVICES

A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 8 hours on-Site for each visit, to the Site. The first visit shall be for assistance in the installation of equipment. Subsequent visits shall be for checking the completed installation, start-up and training of the system. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

END OF SECTION

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SECTION 11521
BELT FILTER PRESSES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install belt filter press(es) sludge dewatering equipment, complete and operational.
   2. Provide the following with each belt filter press:
      a. Belt filter press unit, with three zones of dewatering: gravity zone, drum zone, and pressure zone. Pre-assembled unit shall be complete with frame, drainage pans, discharge assembly, dewatering belts, belt drives, and all appurtenances specified.
      b. Access platforms, stairs, supports, handrails, and appurtenances.
      c. Belt filter press control panel as specified.
      d. Belt drive variable speed drives.
      e. Anchorage devices.
      f. Polymer mixer injection ring
      g. Water booster pump

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before belt filter press Work.
   2. Notify other contractors in advance of the installation of belt filter presses to provide them with sufficient time for installing items included in their contracts that must be installed with or before the belt filter press Work.

C. Related Sections:
   1. Section 01410, Testing Laboratory Services
   2. Section 01610, Transportation and Handling
   3. Section 01650, Facility Startup
   4. Section 01664, Training
   5. Section 03600, Grout
   6. Section 05051, Anchor Systems
   7. Section 05120, Structural Steel
   8. Section 05130, Structural Aluminum Framing
   9. Section 05500, Miscellaneous Metals
   10. Section 05524, Component Aluminum Handrails
   11. Section 09900, Painting.
   12. Section 11400, Package Control Systems
   13. Section 16150, Electrical Motors
   14. Section 16515, Adjustable Frequency, Controlled Speed, Drive Systems.
   15. Section 17000, Instrumentation, Control and Monitoring System General

Requirements
16. Section 17211, Process Taps and Primary Elements
17. Section 17260, Process Control Panels and Hardware
18. Section 17275, Miscellaneous Panel Instruments
19. Section 17400, Programmable Logic Controllers

1.2 REFERENCES

Standards referenced in this Section are:

A. American National Standards Institute (ANSI).
B. APHA/AWWA/WEF, Standard Methods for Examination of Water and Wastewater.
C. American Society of Mechanical Engineers (ASME).
D. ASTM A36/A36M, Specification for Carbon Structural Steel.
E. ASTM A123 Standard Specifications for Zinc (Hop-Dip Galvanizing) Coatings on Iron and Steel Products
F. ASTM A384/A384M, Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
G. ASTM A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
H. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
I. AWS D1.1/D 1.1M, Structural Welding Code - Steel.
J. National Electrical Manufacturers Association (NEMA).
K. SSPC SP10, Near-White Blast Cleaning.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years' experience producing substantially similar equipment to that specified in this Section and shall be able to document at least five installations in satisfactory operation for at least five years.
   2. Welding Qualifications: Equipment manufacturer's shop welds and welding procedures and personnel shall be qualified and certified per AWS D1.1/D1.1M.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of component manufacturer from a single belt filter press manufacturer.
   2. Belt filter press manufacturer shall review and approve or to prepare all Shop Drawings and submittals specified in this Section for all components furnished under this Section.
   3. All components shall be fully suitable for specified service conditions and shall be integrated into overall assembly by belt filter press manufacturer.

C. Pre-fabrication Testing at Site:

CONTRACTOR shall base the Bid and performance guarantees upon the design criteria stated in this Section. No sludge will be available for testing belt filter presses until the belt filter presses become operational.

D. Certifications:

Certification of Compliance:

1. Obtain certification of compliance with the Contract Documents from the belt filter press manufacturer on manufacturer letterhead; certification by manufacturer's representatives is not acceptable.
2. Manufacturer to have ISO 9001 certification.
3. Certification shall be worded as follows:

"[*Insert manufacturer's name*] proposes to supply equipment included in Section 11521 for the City of Atlanta Department of Watershed Management, Atlanta, Georgia, East Area Water Quality Control Facility Improvements. We have examined the Contract Documents and have a clear understanding of the requirements insofar as they affect the proposed products. We certify that the products will operate satisfactorily under the conditions described in the Contract Documents and that the products meet the requirements of the Contract Documents:

[*List exceptions, deviations, or changes necessary to accommodate the proposed products*.]

We further certify that the products to be furnished shall conform to the standards listed in Section 11521 of the Contract Documents.

[*List exceptions, deviations, or changes necessary to accommodate the proposed products*.]

_____ _____

Authorized Signature & Title Date

4. Provide justification for exceptions, variations, deviations, or changes. ENGINEER will determine whether exceptions, deviations, or changes are acceptable. Exceptions, variations, deviations, or changes may result in rejection of products.
5. Compatibility of Programmable Logic Controllers (PLC) and Variable Frequency Drives (VFD): Attach the following to certification of compliance:
   a. Letter from the equipment manufacturer stating that PLCs furnished by manufacturer, VFDs furnished and installed by CONTRACTOR, and belt filter press equipment provided under this Section are fully compatible and will successfully operate under operating load conditions and all other operating characteristics provided by control package specified and shown.

b. Letter from CONTRACTOR stating that PLCs to be furnished by manufacturer and VFDs to be provided by CONTRACTOR are fully compatible with belt filter press equipment specified in this Section, and that CONTRACTOR has fully coordinated all efforts and requirements for complete and operable belt filter press equipment.

6. Provide certification before submitting Shop Drawings. Shop Drawings will not be reviewed prior to receipt of certification.
7. Acceptance of certification shall not relieve CONTRACTOR of responsibility for adequacy of all products.
8. Submittal of certification shall not relieve CONTRACTOR and Supplier from complying with submittal procedures in the Contract Documents.

1.4 SUBMITTALS

A. Action Submittals:
1. Shop Drawings: Submit the following:
   a. Drawings showing fabrication methods, assembly, layout at Site, accessories, installation details, and wiring diagrams. Include in layout Shop Drawings proposed primary and alternate polymer injection locations.
   b. List of deviations from the Contract Documents.
   c. Drawings and information for control panels and instruments, including complete control panel details, wiring diagrams showing all electrical connections to motors and variable speed controls, logic diagrams, PLC data, and detailed specifications conforming to this Section, Section 17000, Instrumentation, Control and Monitoring System General Requirements, Section 17260, Process Control Panels and Enclosures, and Section 17275, Miscellaneous Panel Instruments. This includes submittal of panel wiring drawings, hardware, circuit breakers, motor starters (if included in control panel), and electrical devices furnished.
2. Product Data:
   a. Manufacturer's literature, illustrations, specifications, and engineering data including: materials, dimensions, general arrangement, outline drawings, size, weight, parts lists, performance data, and motor horsepower.
   b. Motor data, including type, size and model number; assembly drawings, rated size of motors with calculations supporting selected motor size; temperature rating; running light current, locked rotor current; and efficiency at 1/2, 3/4, and full load.
   c. Provide manufacturer's standard warranty for parts and labor.
3. Testing Plans: Prior to performing tests, submit and obtain ENGINEER's approval of test procedures for shop testing and field testing.

B. Informational Submittals: Submit the following:
1. Certificates:
   Certification of compliance as specified in this Section, including letters on PLCs and VFDs from manufacturer and CONTRACTOR.

2. Design Data: Structural computations demonstrating that the following complies with Specifications:
    a. Belt filter press frame.
    b. Belt filter press rollers.
3. Test Reports: Submit written reports of:
    a. Shop Tests: Provide prior to shipment from factory, including control panel tests.
    b. Field tests, including field performance testing.
4. Manufacturer's Instructions: Submit manufacturer's instructions and recommendations for:
    a. Storage.
    b. Handling.
    c. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
    d. Installation.
5. Manufacturer's Reports:
   Submit a written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained.
6. Qualifications Data:
    a. Manufacturer.
    b. Welders, including welders' certifications.

C. Closeout Submittals:
1. Operational and Maintenance Data:
    a. Submit complete operation and maintenance manuals, including copies of test reports, maintenance data, and schedules, descriptions of operation, and spare parts information.
    b. Furnish operation and maintenance manuals.
2. Warranty documentation, conforming to requirements of this Section.
3. Spare Parts:
    a. Furnish the following spare parts for each press:
        1) Two complete sets of belts. Provide belts following successful start-up to allow evaluation of performance of installed belts.
        2) Two complete sets of doctor blades.
        3) Two complete sets of bearings and bearing seal rings.
        4) One complete set of wash water spray nozzles.
        5) One complete set of edge seals for dewatering zones.
        6) One complete set of drive unit components for one belt filter press, including motors, speed reducers, drive belts, chains, sprockets, and related items for each type and size of drive unit provided.
    b. Furnish supply of all greases and lubricants required for start-up, field testing, and first year of operation. Products shall be as recommended by the manufacturer
    c. Furnish maintenance repair kit for belts and repairable wear items as recommended by equipment manufacturer.
    d. Furnish and deliver spare parts, consumables, and special tools carefully

packed in sturdy containers with clear indelible identification markings. Properly store spare parts, consumables, and special tools until transferred to OWNER.

e. Control Panels Spare Parts
   1) One CPU of each type utilized.
   2) One spare digital input modules of each type utilized.
   3) One spare digital output modules of each type utilized.
   4) One spare analog input modules of each type utilized.
   5) One spare analog output modules of each type utilized.
   6) One spare power supply assembly of each size utilized.
   7) One spare Ethernet interface modules of each size utilized.
   8) One PLC rack of each type utilized.
   9) One dozen fuses of each size furnished.
   10)One EtherNet/IP Tap for each type furnished.

f. Provide list of additional recommended spare parts for operating period of one year. List shall describe each part, quantity recommended, and unit price of the part.

4. Special Tools: Furnish two sets of special tools required for normal operation and maintenance.
5. Provide the commissioned PLC and OIT program to the City in its native electronic format and load it into the City's configuration Laptop computer.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
   2. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
   3. Conform to Section 01610, Transportation and Handling.

B. Storage and Protection:
   1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
   2. Conform to all product storage and handling requirements of these specifications.

1.6 WARRANTY

Belt Filter Press Warranty: Guarantee that belt life of each belt furnished shall not be less than 3,000 hours of operation. Replace belts not providing the specified wearability in normal usage; replace at no additional cost to OWNER belts providing less than 2,000 hours of operation. Cost of replacement belts parts and labor for belts that provide

between 2,000 and 3,000 hours of operation will shared by OWNER and CONTRACTOR on pro-rata basis.

The equipment shall be guaranteed against defects in material and workmanship under normal use and service for a period of one year after start-up not to exceed eighteen months after shipment during which time replacements parts shall be provided without charge. Further, an additional four year warranty (total of five years) shall be provided for the belt press frame and its coating, the belt press rollers and their coatings and the belt press roll bearings.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Belt filter presses shall:
      a. Be constructed for continuous operation in humid and corrosive environment.
      b. Employ woven polyester belts arranged to perform sludge conveying, pressing, and dewatering.
      c. Be continuous belt design with three dewatering zones including gravity drainage zone, followed by wedge zone, and an increasing-pressure drum and roller zone. Equipment shall be the type that entrains sludge between two continuous, open-meshed belts with system of perforated and solid rollers. Belt tension system shall act on the rollers exclusively to provide increasing pressure as sludge advances toward the equipment's discharge. Belt filter press shall be complete with all necessary motors, gear drives, hydraulic system, control panel, alarm system, wash water booster pump, belts and belt wash system, and appurtenances. Dewatered sludge shall then be removed from the belts with scrapers (doctor blades) and belts shall then be washed prior to receiving additional sludge.
      d. Utilize chemical conditioning by one liquid organic polyelectrolyte chemical (polymer) readily available in bulk quantities. Conditioning with inorganic chemicals such as lime or ferric chloride is unacceptable.
   2. Equipment shall be monitored and controlled from a belt filter press control panel, to be furnished by the manufacturer.
   3. Provide all appurtenant equipment and piping normally furnished as an integral component of belt filter press and required for proper operation of belt filter press, whether or not specifically required in the Specifications.
   4. Design and performance criteria of unit specified shall meet minimum requirements. When installed and operating, equipment shall meet or exceed specified minimum performance requirements.
   5. Equipment shall be completely factory assembled and tested, unless otherwise specified in this Section. Equipment main frame assembly shall require only bolting to floor at the Site and connection of external piping and electrical wiring. Flocculation devices, belts, pre-dewatering drums, and other equipment that may be damaged during shipping if mounted on main frame

shall be installed following delivery to Site by Supplier's representative. All electrical components located on the machine shall be pre-wired at the factory.

6. Assembly Relative to Maintenance:
   a. Routine maintenance shall be possible without taking equipment out of service.
   b. Belts shall be replaceable without requiring disassembly of belt filter press.
   c. Parts requiring routine maintenance shall be readily accessible from outside the belt filter press. Side panels, when furnished, shall be removable for access to belt filter press components and shall be securely attached to frame.

B. Design Criteria:

Sludge Characteristics:

1. Type of Sludge: Primary Sludge – Combined Sewer Overflow Treatment
2. Number of Units: 1
3. Sludge Throughput:
   a. Design Solids to Belt Filter Presses: 24,200 lbs per day.
   b. Sludge Concentration: 2% dry weight solids, minimum.
4. Hours of Operation: 24 hours per day, approximately 3 days per week for maximum month's average sludge production.
5. Design Sludge Flow Rate to Belt Filter Presses: 130 gpm per belt filter press.
6. Minimum Required Cake Dry Solids at Average Percent Feed Sludge Dry Solids: 30 percent.
7. Minimum Solids Capture: 95 percent (filtrate solids plus wash water solids).
8. Maximum Polymer Usage at Average Percent Feed Sludge Dry Solids: 20 lbs active polymer per ton of feed sludge dry solids.
9. Number of Belt Filter Presses Required: 1
10. Maximum Hydraulic Throughput to Belt Filter Press at Design Sludge Production: 65 gpm per meter per belt filter press.
11. Minimum Effective Belt Dewatering Width per Belt Filter Press: 2.0 meters.

2.2 MANUFACTURERS

Manufacturers: Provide equipment of one of the following:

A. Komline-Sanderson – Kompress – GRSL-2 Series III
B. Andritz
C. Alfa Laval Ashbrook Simon-Hartley
D. Or Equal.

2.3 DETAILS OF CONSTRUCTION

A. General:

1. Bearings shall be split case construction and shall have minimum B-10 rating of 800,000 hours. Lubrication fittings shall be provided at outside faces of equipment.
2. Motors: Motors shall have minimum service factor of 1.15, unless controlled by a VFD. Motors and drives shall be TEFC and shall be sized to be non-overloading over the full range of operating conditions specified.
3. PLC shall be a ControlLogix Series as manufactured by Allen Bradley and shall complied with the requirements of this Section and Section 17275, Miscellaneous Panel Instruments. Belt filter press manufacturer shall:
    a. Furnish and install the PLC(s) and Remote I/O for the belt filter press equipment in an NEMA 4X, 316L type Stainless steel enclosure as specified in Section 17260, Process Control Panels and Hardware. Provide all required Panel mounted instruments and hardware as specified in Section 17275, Miscellaneous Panel Instruments.
    b. Belt filter press Remote I/O panel shall be provided in the Sludge Feed Pump Station building, following equipment shall be hardwired to the Remote I/O:
        1. Sludge Feed Pump No. 1 VFD
        2. Sludge Feed Grinder No. 1
        3. Sludge Feed Pump No. 2 VFD
        4. Sludge Feed Grinder No. 2
    c. PLC Ethernet TAP (ETAP) shall be 1783-ETAP series as manufactured by Allen Bradley, with minimum one Copper and one Fiber port. ETAP shall be utilized to make the appropriate ring topology as shown in the contract drawing between the BFP Control Panel PLC, OIT and the Remote I/O panel.
    d. Assume unit responsibility for PLCs furnished for belt filter press equipment and control panels, including input and output capacity and capability to successfully control all devices and systems controlled by the PLCs, and to send and retrieve data over Ethernet between belt filter press PLC(s) and The Plant-wide Foxboro Distributed Control System (DCS), as shown and specified. Communication protocol shall be Ethernet IP, No exceptions.
    e. Two separate communication cards shall be utilized in the Belt Filter Press PLC, one for the Ethernet IP communication link with Plant-wide Foxboro Distributed Control System and the other for the communication link going to the OIT and Remote I/O panel.
    f. Provide letter with submittal stating that PLCs to be furnished are same manufacturer as PLC approved under Section 17275, Miscellaneous Panel Instruments., that all control elements and features as shown and specified have been configured into PLC logic, and that PLC will successfully meet all the control requirements as specified and as shown.
4. Provide variable frequency drives (VFD) associated with belt filter press equipment. Belt filter press manufacturer shall submit a letter of compliance stating that motors for belt filter press system are suitable and compatible with VFDs provided under Section 16515, Adjustable Frequency, Controlled Speed, Drive Systems.

B. Mechanical Components:

1. Sludge/Polymer Mixer. Provide each belt filter press with sludge/polymer mixer. Provide sludge conditioning system upstream of belt filter press.
    a. Sludge/polymer mixer assembly shall be an inline, non-clog, variable orifice, venturi type mixer with polymer injection ring, flow splitting manifold, tubing, and fittings between injection ring and manifold. Each polymer injection ring shall inject polymer at minimum of four points located 90 degrees apart around circumference of ring. Inside diameter of ring shall not be less than inside diameter of associated sludge feed piping.
    b. Mixer Requirements:
        1) Material: Type 316L stainless steel.
        2) Provide with flapper-type check valve with external adjustable stop nut and counterweight. Position of counterweight on externally mounted orifice plate lever shall be fully adjustable, within 360-degree circle, for varying the mixing energy regardless of mounting angle, while unit is operating.
        3) Open throat area shall be fully adjustable downward and shall open automatically to prevent clogging.
        4) Mixer shall be equipped with ANSI-compatible flanges at each end suitable for adjacent piping.
        5) Mixer shall have removable side plate for inspection and cleaning.
    c. Provide on belt filter press sludge feed piping three alternate polymer injection locations. Polymer injection point shall be adjustable by removing flanged pipe spool piece at each alternate injection point and installing polymer/sludge mixer. The Drawings show only locations based on achieving 8-22 second flocculation time at 101 gpm (dependent on mixer spool locations, approximately 20, 40, and 55 feet upstream of discharge to press and flow velocity of 2.6 fps) prior to discharging to belt filter press. Belt filter presses manufacturer's submittal shall provide manufacturer's recommended layout for system with primary and two alternative locations shown. CONTRACTOR shall provide flanged spool piece to facilitate disassembly at each of the alternate locations, and provide sludge pipe coupling at each of the primary and alternate locations.
    d. Unacceptable systems include: static mixers with stationary baffles, modified check valves, mixers requiring electric motors and controls, or tanks with mechanical mixers.
2. Gravity Dewatering Zone: Shall accept flocculated sludge from sludge/polymer mixing system, and allow free water in conditioned sludge to readily separate from the solids and drain to collection pan.
    a. Gravity drainage zone shall have minimum dewatering area of 100 square feet.
    b. Provide gravity drainage zone with sludge inlet assembly consisting of distribution chute and leveling weir designed to evenly distribute conditioned sludge across entire effective width of moving filter belt.

c. Materials in contact with sludge in distribution area shall be Type 316L stainless steel with minimum thickness of 14-gauge.
d. Conditioned sludge shall be contained on filter belt with adjustable containment barriers equipped with replaceable rubber seals that prevent leakage. Containment barriers shall be minimum 14-gauge Type 316L stainless steel, and be mounted on both sides of filter belt and at sludge feed end of gravity drainage zone. Equip side skirts with urethane seals or other elasticized materials to prevent sludge spills. Attach replaceable rubber seals to containment barriers with friction fit.
e. Furnish gravity drainage zone with chicanes (plows) to adequately furrow conditioned sludge to promote water drainage from sludge. Provide each row of chicanes with single lifting handle that removes entire row of chicanes at least six inches from filter belt, out of the sludge flow, for cleaning. Chicanes shall be individually adjustable laterally and shall pivot to allow chicanes to pass over obstructions on filter belt. Each set of chicanes shall be mounted on Type 316L stainless steel horizontal support bar.
f. To minimize belt sagging, gravity dewatering zone filter belt shall be supported by either a grid or plate or belt support bars designed to minimize belt wear and facilitate free drainage of water. Support shall be at least two inches wider than filter belt on each side. Wear strips, if used, shall be replaceable without removing or disassembling gravity dewatering zone sidewalls and chicane assemblies.

3. Wedge Dewatering Zone: After gravity dewatering zone, sludge shall enter pressure dewatering zone. Wedge zone consisting of two belts that gradually converge in an adjustable wedge angle to generate continuously, increasing pressure, shall squeeze water out of sludge. Both sides/edges of wedge dewatering zone shall be sealed with sealing material to contain the sludge in the zone. Wipers shall remove water from both sides of filter belt.
4. Drum Pressure Dewatering Zone:
   a. Shall consist of dewatering drums that shall alternately apply shear and compression to sludge cake by passing cake sandwiched between the two pressure belts over drums in serpentine configuration. Belts shall then pass around and through series of rollers arranged in an S-configuration that shall exert high pressure on sludge to produce sludge cake with specified dry solids content. Pressure may be achieved by any of, or a combination of, the following:
      1) High belt tension.
      2) Successively decreasing roller diameters.
      3) Separate high tension belt that presses against the two belts containing the sludge cake to increase pressure on cake.
      4) Adjustable pressure rollers that compress the sludge cake.
   b. Drum pressure dewatering zone belts shall be driven by variable speed drive.
5. Doctor Blades:
   a. Equip belt filter press with doctor blades for removing dewatered sludge from belts. Install doctor blades to facilitate periodic inspection and

cleaning. Operation of doctor blades shall be minimize wear on the belt seam.

b. Doctor blades shall be:
   1) Dual edge (reversible) type with adjustable springs or counterweights to maintain pressure against the belts
   2) Constructed of UHMW polyethylene.
   3) Readily removable.
   4) Positioned on each belt at discharge end of belt filter press to effectively remove sludge cake from belts.
   5) All springs and hardware shall be stainless steel.
   6) Provide lifting device to allow movement of blades away from belts for cleaning without requiring belt filter press shutdown.

6. Belts, General:
   a. Provide each belt filter press with one complete set of belts.
   b. Belts shall be of woven polyester monofilament, of either seamed or seamless type.
   c. Seamed belts shall have mechanical seam that does not interfere with belt filter press operation and facilitates belt replacement. Belt seam closures shall be stainless steel.
   d. Belts shall be heat-set, and belt edges shall be double-reinforced with 1/2-inch plastic band. Belt edges that are heat sealed only are unacceptable.
   e. Pre-stretch each belt at the factory to limit belt elongation to less than three percent of overall belt length.
   f. All belts, including separate high tension belts supplied as part of the belt filter press, shall be capable of continuously withstanding maximum tensile force of three times maximum tension to which belt will be subject under normal operation.
7. Belt Tensioning:
   a. Tension each belt independently of other belts via hydraulic actuators. Belt tension shall be variable and tension adjustment shall be possible while belt filter press is operating. Either tensioning system shall maintain constant tension on belt regardless of cake thickness. Provide pressure gage or similar device to indicate belt tension in pounds per unit width, or actuating cylinder fluid pressure in pounds per square inch. Normal operating limits shall be indicated on gage face.
   b. Operation of belt tensioning system shall ensure simultaneous and parallel movement of tensioning roller ends during adjustment and accommodate up to three percent belt elongation.
8. Belt Tracking:
   a. Belt alignment devices shall be provided on each belt to automatically correct belt's lateral deviation from center of rollers. Each belt's alignment sensing device shall be located on both sides of each belt near belt alignment device. Belt alignment device shall be actuated via hydraulic actuators. Belt tracking system shall be provided so that belt position adjustments are performed smoothly without sharp or sudden movements of filter belt or alignment roller.

b. Provide rotary actuated, double pole/double throw (DPDT) limit switches rated 10 amperes at 120 volts in NEMA 4X enclosure to detect extreme belt travel, initiate shutdown signal, and activate remote alarm.

9. Hydraulic System:
   a. Provide one hydraulic system per each belt filter press, each including hydraulic pump and motor, reservoir with sight glass, filters, valves, gages, piping, and controls required for operation. Provide suitable pressure switch with DPDT contacts rated 10 amperes at 120 volts in NEMA 4X enclosure to activate an alarm upon low hydraulic fluid pressure. Hydraulic power unit shall be frame mounted on the BFP.
   b. Hydraulic pump motor shall be TEFC with Class F insulation. Motor shall be minimum of 1 horsepower, with maximum speed of 1,800 rpm, suitable for operation on 460-volt, 3-phase, 60 Hertz power.
   c. Hydraulic pump controls and system components shall be mounted to a common baseplate with the frame mounted hydraulic power unit.
10. Belt Washing Stations:
   a. Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a spray pipe, fitted with spray nozzles, contained within a fabricated housing which encapsulates a section of each belt. The housing and nozzle assembly shall be readily removable. Housing shall be 316 stainless steel.
   b. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable.
   c. The housing shall be sealed against the belt with rubber seals. The spacing between the upper and lower housing shall be adjustable to insure continuous contact between the seals and belt. The seals shall be replaceable without disassembly of the wash station.
   d. Each belt wash station shall be furnished with a drain valve having an external handwheel to which is mounted a stainless steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve and allow the solid particles to be flushed into the drainage system.
   e. Belt wash stations shall be the type manufactured by Appleton Manufacturing, Menasha Corporation, Menasha, Wisconsin, or equal.
   f. Each belt wash station shall be positioned such that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend over the full width of the filter belt by a minimum of two (2) inches. The belt shall be cleaned by the belt wash with no blinding. The belt wash system shall be suitable for use with plant effluent water or potable water supplied to the wash stations at a minimum pressure of 85 psig and shall be designed to operate at a flow of 80 gpm.
   g. Washwater pressure shall be supplied to a washwater pump provided by the belt press manufacturer at a minimum of 30 psig, and the

washwater pump shall be rated at sufficient capacity and discharge head to meet the process requirements. All controls and equipment necessary to provide a complete and operating system for the pumps shall be provided by the belt press manufacturer, including the controls from the machine control panel as specified hereinafter. The washwater pump shall be driven by a 460V, 3 phase, 7.5 HP maximum, 1800 RPM, severe duty motor with 1.15 SF.

h. Each belt filter press shall be provided with a 1 1/2-inch female PVC connection for belt wash water.

11. Drives and Motors:
    a. Motors shall conform to requirements of Section 16150, Electric Motors.
    b. Motors shall be premium efficiency, severe duty type, TEFC units, of ample power for starting and operating under normal operating conditions without exceeding nameplate horsepower. Motors shall be suitable for operation on 480-volt, 3-phase, 60-Hz power. Provide space heater in each motor frame. Unit shall have anti-friction bearings and be cast-iron construction. Drive shall be operated from belt filter press control panel. Provide tachometer on each drive to monitor and transmit actual drive speed to indicating meters on belt filter press control panel.
    c. If independent belt is provided for gravity dewatering, belt shall be driven by an independent drive train.
12. Drainage Pans:
    a. Drainage pans shall be provided as necessary to contain filtrate from all dewatering areas within the belt filter press without splashing and to prevent rewetting of downstream cake. All drainage piping shall be furnished, adequately sized for the intended service, and rigidly attached to the press frame. Drainage piping shall terminate inside the structural frame at the bottom of the press. Drain connection shall be self-venting to prevent overflow. Drainage pans shall be located so that the moving belts do not come into contact with the pans under any condition.
13. Bearings:
    a. Bearings on belt filter press shall have a B-10 rating of at least 800,000 hours and be grease lubricated. Provide lubrication fittings at outside of belt filter press for servicing. Bearings shall be self aligning, roller or ball bearing type, in horizontally split cast-iron housings with triple seals. Bearings shall be outboard mounted and field replaceable without affecting factory alignment and without requiring major disassembly. Bearings shall be re-greaseable while press is running.
    b. Products and Manufacturers: Provide products of one of the following:
        1) SKF Model No. SAF-22513.
        2) FMC Model No. PLB6835AC.
        3) Or equal.
15. Rollers:

    Non-perforated rollers shall ASTM A36/A36M or ASTM A500 carbon steel and coated as specified in this Specification Section, or Type 316 stainless steel, each with a continuous through-shaft or with stub shafts supported by double, separated end plates, all welded in place. Stub shafts welded directly

to single end plates are not acceptable. Rollers shall have maximum deflection of 0.05-inch at mid-span when subjected to maximum operating loads. Minimum roller wall thickness shall be 1/2-inch. Perforated rollers shall be Type 316 stainless steel. Drive rollers, regardless of material of construction, shall be coated with manufacturer's standard vulcanized rubber coating. Provide drive rollers with drainage channels or other suitable means to assist in removing water and preventing slippage.

16. Cake Thickness Monitoring System:
    Thickness of sludge cake shall be continually monitored by a floating roller or other device. If pre-adjustable cake thickness is below or above preset limit, an alarm shall be activated after an adjustable time delay.
17. Terminal Boxes:
    Provide two terminal boxes, 316L stainless steel rated NEMA 4X. All 120-volt, single-phase devices shall be pre-wired to one terminal box, and all DC control wiring shall be pre-wired to the second terminal box.
18. Belt Filter Press Frame Structure:
    a. Each main structural frame shall be fabricated of structural steel members and plates sized to carry maximum loads to which they will be subjected under normal service conditions without permanent deformation or deflection that will interfere with normal operating clearances and tolerances. The frame shall have minimum safety factors of nine times the allowable yield strength in bending and ten times the allowable shear stress at an applied belt tension of 50 pounds per linear inch. Frame deflection shall not exceed 0.002 inch under the same belt tension load. Main frame shall be sufficiently strong so that shop assembled belt filter press can be lifted by crane and set in place at the Site. Frame shall be fabricated from steel conforming to ASTM A36/A36M, or from steel structural tubing conforming to ASTM A500.
19. Press Components:
    All components including panels and plates, fabricated subassemblies, tanks, rollers, drives, and piping shall be adequately sized to avoid failure due to stress, fatigue, or creep during useful life of the equipment. Rollers shall be of sufficient strength to avoid permanent deformation under maximum belt tension to which they will be subjected. Rollers provided with thru-shafts shall have shaft deflection and roller deflection properly matched.
20. Safety Cord:
    Provide on both sides of each belt filter press a nylon pull cord in ring supports. Provide controls and appurtenances so that, when cord is pulled, emergency shutdown of all belt filter press motors and appurtenant equipment will result. Associated stop switch contacts shall be DPDT, rated 10 amperes at 120 volts.
21. Access Platform:
    a. Each belt filter press shall be installed on concrete piers or pedestals at a height to satisfactorily discharge to belt conveyor. Manufacturer shall design and provide the access platforms, handrails and stairs as indicated on the Drawings. Provide appropriate access platform and stairs to provide access to all components of belt filter press that are 5.0 feet or higher above operating floor and that require observation, operation,

adjustment, or maintenance. Platforms shall be mounted to operating floor of the building, and shall be fabricated of structural aluminum, with walkway of aluminum grating and aluminum handrail with toe boards.

b. Structural aluminum shall conform to the requirements of Section 05130, Structural Aluminum Framing.

c. Aluminum grating and handrail shall conform to the requirements of Section 05524, Component Aluminum Handrails and Section 05550, Miscellaneous Metals.

22. Anchorages: Provide anchor anchorage hardware of ample size and strength for purpose intended, sized by equipment manufacturer. Anchorage materials shall conform to Section 05051, Anchor Systems.

2.4 FINISHING

A. Plates or grids in gravity drainage zone, all spray water piping and nozzles, filtrate and wash water collection pans, and other appurtenances directly exposed to sludge, filtrate, or wash water shall be of Type 316 stainless steel.

B. Clean all carbon steel rolls, including stub shafts up to the point of insertion into bearing block per SSPC SP 10, and protect against corrosion by one or more of the following methods as applicable:

1. Vulcanized rubber roller coverings selected to resist deterioration upon exposure to
sludge, filtrate, or wash water.
2. Thirty-mil minimum thickness Rilsan or other approved nylon coating.
3. Two-hundred-mil minimum thickness machined and polished fiberglass reinforced
plastic.
4. Other coatings applied to rollers in such manner to bond to steel roller and that provide
abrasion- and corrosion-resistant coating.

C. Clean structural steel frame members per SSPC SP 10 and provide one of the following coatings:

1. Provide non-stainless steel metal surfaces with hot-dipped zinc-galvanized coating with minimum thickness of 4.0 mils. Hot-dipped zinc coating method shall minimize distortion and warpage of components being galvanized and shall conform to requirements of ASTM A384/A384M, ASTM A385 and ASTM A123.
2. Provide metal, non-stainless steel surfaces with one coat of epoxy primer with minimum dry film thickness of 1.5 mils, followed by one coat of epoxy paint with minimum dry film thickness of three mils, and one coat of an epoxy glaze finish coat with minimum dry film thickness of 1.5 mils.
3. Cover metal, non-stainless steel surfaces with individual layers of resin soaked fiberglass approximately 1.0 mm thick, one coat of epoxy primer with minimum dry film thickness of one mil, followed by one coat of epoxy coating

with minimum dry film thickness of one mil, and one coat of epoxy glaze finish coating with minimum dry film thickness of one mil.

D. Apply all structural frame coatings after fabrication, prior to installing component parts. Do not weld, cut, drill or otherwise deface frame members after applying coating.

E. ENGINEER will select all finish colors from standard color charts to be supplied by Supplier.

F. Motors, gearboxes, and similar items shall be furnished with manufacturer's standard finish.

G. Coat gears, bearing surfaces, and other unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until equipment is placed into operation.

2.5 BFP AND BFP REMOTE I/O CONTROL PANELS

A. General:
1. Provide one control panel with the PLC for the belt filter press control. Fiber patch panel shall be provided as per specification section 17940 Communication Links as shown in the contract drawing.
2. BFP Control Panel shall be a combination VFD/PLC panel and shall include the following door controls:
   a) Operator Interface Terminal (OIT).
   b) Power ON indication light.
   c) "EMERGENCY STOP" red mushroom.
   d) Alarm Silence/Acknowledge pushbutton.
   e) Reset pushbutton.
   f) ON/OFF selector switch.
   g) Horn and beacon.
3. Provide one BFP Remote I/O panel for the Sludge Feed Pumps and Grinders located in the Solids Processing building.
4. BFP Remote I/O Panel shall be linked to the BFP Control panel via fiber optic communication link forming a Remote IO Ethernet ring topology. and shall have the "Power ON" indication light on exterior. Fiber patch panel shall be provided as per specification section 17940 Communication Links and as shown in the contract drawing.
5. Control panels shall be 316L stainless steel NEMA 4X and shall conform to Section 17260, Process Control Panels and Hardware.
6. The VFD/PLC panel shall be separated into two distinct compartments, one with 480 VAC devices and the second with 120 VAC PLC controls. The compartments shall be positioned one above the other and separated with a protective barrier and have separate doors for protection of maintenance staff.

7. Controls for remote, electrically-operated or motor-driven equipment shall be complete and available at the OIT, including all necessary auxiliary relays to require only wiring and connection to equipment's control circuit.
8. Factory test control panel prior to shipment, per this Specification Section 17000, Instrumentation, Control and Monitoring System General Requirements.
9. Furnish 480-volt, 3-phase, 60 Hertz power feeder to belt filter press control panel. Include main disconnect switch, transformer(s), and circuit breaker load center for all 120-volt panel power requirements.
10. Separate all 120-volt devices from 480-volt devices.
11. Install SCR controllers, if provided, within belt filter press control panel and provide with individual circuit breaker or fused-type disconnect switches and contactors. Provide suitably sized transformers to provide proper power and control voltage for SCR controllers.
12. Provide mechanical, variable speed, AC drives, if furnished, with circuit breaker combination-type starters for each drive, including control power transformers of suitable size with all necessary relays and timers provided as shown in the Drawings. Provide all soft "START/STOP" pushbuttons, indicating lights, speed indicating motors, control logic relays, and other controls in belt filter press control panel.
13. Panel devices shall conform to Section 17275, Miscellaneous Panel Instruments.
14. Provide surge protectors for panel power feed entrance. Surge Protector Devices shall conform to Section 17260, Process Control Panels and Hardware. Wire all surge protector remote fail indication in series and send the common signal to the PLC.
15. Control of Environment:
    a. Provide 120 vac thermostatically-controlled fan-driven heater units to maintain stable temperature within enclosure to protect equipment from harmful effects of condensation, corrosion, and low temperatures inside panels.
    b. Provide automatically controlled closed-loop heat exchangers or closed-loop air conditioners to maintain temperature inside each enclosure at optimum operating temperature rating of components inside the enclosure.
    c. Each heat exchanger or air conditioner shall have a dedicated, properly-sized and -rated circuit breaker.
    d. Submit supporting calculations as part of panel Shop Drawing submittal if panel equipment to comply with specified environmental requirements is proposed to be deleted as unnecessary.
    e. Panels to be located in non-hazardous (non-classified) environments shall comply with UL 50 and UL 508A.

B. Controls, Instruments, and Devices:
1. Arrange each belt filter press control panel to allow either manual or automatic mode control of belt filter press equipment from the OIT. When "MANUAL" operation is selected, all equipment associated with belt filter press shall be controlled using the "START/STOP" pushbuttons. When "AUTOMATIC"

operation is selected, control of equipment shall be "AUTOMATIC/START" and "AUTOMATIC/ STOP" pushbuttons, and programmable controller:

a. Each belt filter press control panel shall include the following:
    1) One control mode selector switch marked "AUTOMATIC/ MANUAL." When "MANUAL" operation is selected, all equipment associated with belt filter press shall be controlled by "START/STOP" pushbuttons. Provide one "START" and one "STOP" pushbutton for each of the following:
        a) Belt filter press drive.
        b) Hydraulic power supply.
        c) Wash water pumps.
        d) Sludge cake conveyor.
        e) Polymer feed System.
        f) Solids Processing (Sludge feed) Pump #1.
        g) Solids Processing (Sludge feed) Pump #2.
        h) Sludge Holding Tank.
    2) "INCREASE" and "DECREASE" momentary pushbuttons for speed adjustment for each of the following
        a) Belt filter press drive.
        b) Polymer feed System.
        c) Solid Processing Pump #1.
        d) Solid Processing Pump #2.
        e) Sludge Holding Tank.
    3) Indication for sludge feed flow rate and polymer solution feed flow rate. Indicators shall accept 4 to 20 mADC field input and shall be calibrated in gpm and gph, respectively.
    4) One "MANUAL/OFF" selector switch for wash water valve operation.
    5) Green indicating lights for "RUNNING" status for each unit operated from panel, including wash water solenoid valve energized indication.
    6) Red indicating lights for "OFF" status for each unit operated from panel, including wash water valve de-energized indication.
    7) One each "AUTOMATIC/START" and one "AUTOMATIC/STOP" momentary pushbuttons, for automatically starting and stopping each belt filter press system. Sludge cake conveyor can be manually controlled when belt filter press control mode selector switch is in either the "AUTOMATIC" or "MANUAL" position. In "AUTOMATIC", The Belt Filter Press control panel shall start and stop the Sludge cake conveyor. The Sludge cake conveyor running feedback shall be use as permissive to operate the belt filter press.
    8) One "ENABLE/DISABLE" selector switch for overriding cake thickness monitoring switch.

2. Minimum PLC Hardwired Input Output points requirement for control of ancillary equipment
    a. Hydraulic power supply.
        1) Pump Start/Stop.
        2) Pump Running Status.
        3) Motor Overload.

4) Low Hydraulic Fluid.
5) Hydraulic system Low Pressure.

b. Wash water pumps.
1) Pump Start/Stop.
2) Pump Running Status.
3) Motor Overload.
4) Wash water valve Open/Close.

c. Polymer feed System
1) Polymer feed System In remote
2) Polymer feed Start/Stop
3) Polymer feed Running Status
4) Polymer feed System Fail
5) Polymer feed System Speed Command
6) Polymer feed System Speed Feedback
7) Polymer System Flow Rate

d. Sludge Feed Pumps.
1) Sludge Feed Pump #1 In Remote
2) Sludge Feed Pump #1 Running Status
3) Sludge Feed Pump #1 Overload
4) Sludge Feed Pump #1 VFD Fail
5) Sludge Feed Pump #1 High Discharge Pressure
6) Sludge Feed Pump #1 Low Pressure
7) Sludge Feed Pump #1 E-Stop
8) Sludge Feed Pump #1 Speed Feedback
9) Sludge Feed Pump #1 Speed Command
10) Sludge Feed Pump #1 Start/Stop
11) Sludge Feed Pump #1 In Remote
12) Sludge Feed Pump #2 Running Status
13) Sludge Feed Pump #2 Overload
14) Sludge Feed Pump #2 VFD Fail
15) Sludge Feed Pump #2 High Discharge Pressure
16) Sludge Feed Pump #2 Low Pressure
17) Sludge Feed Pump #2 E-Stop
18) Sludge Feed Pump #2 Speed Feedback
19) Sludge Feed Pump #2 Speed Command
20) Sludge Feed Pump #2 Start/Stop
21) Sludge Feed Flow

e. Sludge Feed Grinders
1) Sludge Feed Grinder #1 In Remote
2) Sludge Feed Grinder #1 Start/Stop
3) Sludge Feed Grinder #1 Jammed
4) Sludge Feed Grinder #1 Overload
5) Sludge Feed Grinder #1 Run Status
6) Sludge Feed Grinder #2 In Remote
7) Sludge Feed Grinder #2 Start/Stop
8) Sludge Feed Grinder #2 Jammed
9) Sludge Feed Grinder #2 Overload

10) Sludge Feed Grinder #2 Run Status

f. Sludge cake belt conveyor.
   1) Belt conveyor Start/Stop.
   2) Belt conveyor Running Status.
   3) Belt conveyor In remote.
   4) Belt conveyor E-stop.
   5) Belt conveyor Pull cord.
   6) Belt conveyor Overload.
   7) Belt conveyor Zero motion Alarm.
   8) Belt conveyor Misalignment Alarm.

g. Sludge holding tank.
   1) Drive In Remote.
   2) Drive Start/Stop.
   3) Drive Running Status.
   4) Drive Overload.
   5) Drive VFD Fail.
   6) Drive High Torque Warning.
   7) Drive High-High Torque Trip.
   8) Drive E-stop.
   9) Drive Speed Command.
   10)Drive Speed Feedback.
   11)Drive In Remote.
   12) Sludge holding tank level.

h. Surge protection blown.

4. Foxboro DCS shall monitor the following minimum points from the PLC using Ethernet IP protocol over Ethernet.
   a. Hydraulic Pump
      1) Hydraulic Pump Running Indication
      2) Hydraulic Pump Not Running
      3) Low Hydraulic Pressure
   b. Washwater Valve
      1) Washwater Valve Opened Indication
      2) Washwater Valve Closed Indication
      3) Washwater Pump Running Indication
      4) Washwater Valve Closed Alarm
      5) Washwater Valve Open Alarm
      6) Washwater Pump Not Running
   c. Low Water Pressure
   d. BFP
      1) BFP Conveyor Running Indication
      2) BFP in Jog Mode
      3) BFP Ready
      4) BFP Online (Pre-Wash)
      5) BFP Online (Running)
      6) BFP Online (Post Wash)
      7) BFP Online (Discharging)

8) BFP in Alarm
9) BFP Emergency Stop/Trip Rope Pulled
10) BFP Belt Misalignment
11) BFP Low Sludge Feed Flow
12) Belt Drive Running Indication
13) Belt Drive Overtemperature
14) Belt Drive Speed Indication
15) Pressure Belt Broken (Upper)
16) Pressure Belt Broken (Lower)
17) Belt Drive Not Running
18) Belt Conveyor Not Running
19) Belt Conveyor Speed Switch Low
20) Belt Conveyor Emergency Trip Rope

e. Polymer System
1) Polymer Pump Running Indication
2) Polymer Pump Not Running
3) Polymer Pump Not in Remote
4) Polymer Pump External Fault
5) Polymer Pump Speed Indication
6) Polymer Flow Rate

f. Sludge Feed Pumps
1) Sludge Feed Pump #1 In Remote
2) Sludge Feed Pump #1 Running Status
3) Sludge Feed Pump #1 Overload
4) Sludge Feed Pump #1 VFD Fail
5) Sludge Feed Pump #1 High Discharge Pressure
6) Sludge Feed Pump #1 Low Pressure
7) Sludge Feed Pump #1 E-Stop
8) Sludge Feed Pump #1 Speed Feedback
9) Sludge Feed Pump #1 In Remote
10) Sludge Feed Pump #2 Running Status
11) Sludge Feed Pump #2 Overload
12) Sludge Feed Pump #2 VFD Fail
13) Sludge Feed Pump #2 High Discharge Pressure
14) Sludge Feed Pump #2 Low Pressure
15) Sludge Feed Pump #2 E-Stop
16) Sludge Feed Pump #2 Speed Feedback
17) Sludge Feed Flow

g. Sludge Feed Grinders
1) Sludge Feed Grinder #1 In Remote
2) Sludge Feed Grinder #1 Jammed
3) Sludge Feed Grinder #1 Overload
4) Sludge Feed Grinder #1 Run Status
5) Sludge Feed Grinder #2 In Remote
6) Sludge Feed Grinder #2 Jammed
7) Sludge Feed Grinder #2 Overload
8) Sludge Feed Grinder #2 Run Status

h. Sludge cake belt conveyor.
    1) Belt conveyor Running Status.
    2) Belt conveyor In remote.
    3) Belt conveyor E-stop.
    4) Belt conveyor Pull cord.
    5) Belt conveyor Overload.
    6) Belt conveyor Zero motion Alarm.
    7) Belt conveyor Misalignment Alarm.

i. Sludge Holding Tank.
    1) Drive In Remote.
    2) Drive Running Status.
    3) Drive Overload.
    4) Drive VFD Fail.
    5) Drive High Torque Warning.
    6) Drive High-High Torque Trip.
    7) Drive E-stop.
    8) Drive Speed Feedback.
    9) Drive Motor High Winding Temperature.
    10) Sludge holding tank level.

j. Surge protector blown.

5. Foxboro DCS shall write the following minimum points to the PLC to synchronize time and date with the Plant-Wide DCS. Synchronize date and time every day at 4:00 AM with the DCS.
    a. Day
    b. Month
    c. Year
    d. Day of the week
    e. Hour
    f. Minute
    g. Second
    h. Sludge Holding Tank Drive Start/Stop
    i. Sludge Holding Tank Drive Speed Command.
6. Automatic BFP Controls and Sequencing:
    a. General:
        1) Program the PLC and OIT for monitoring and automatic control of each belt filter press, system sequencing, and interlock functions as specified.
        2) Configuration of the OIT and programming of PLC system shall be responsibility of belt filter press manufacturer. System documentation including memory loading, I/O configuration, graphic displays, alarms and programming shall be provided.
        3) Provide and install auxiliary relays and wiring for equipment and devices specified in this Section required for implementing functional requirements specified.
    b. “AUTOMATIC START/AUTOMATIC STOP” Cycle:
        1) Automatic start cycle request to PLC shall be initiated by “AUTOMATIC/START” pushbutton.

2) Control logic for an "AUTOMATIC/START" cycle shall start belt filter press sequence in the following order after "AUTOMATIC/START" command has been initiated and interlocks are complete.
    a) Hydraulic unit. Hydraulic fluid pressure interlock must be satisfied before sequence continues.
    b) Open wash water motorized valve.
    c) Start wash water pump.
    d) Start belt filter press drive(s).
    e) Start duty solid processing pump and grinder.
    f) Start polymer feed pump.
3) Only start each drive after previous drive has is running status confirmed and necessary time delay has elapsed. Belt filter press manufacturer shall determine where time delays are required and shall program settings to provide smooth start-up of equipment.
4) Once all drives are confirmed running by motor run contacts from their respective starters, PLC shall cause the run indicating light to illuminate. Loss of run status contact for a drive once cycle logic is complete shall shut down belt filter press and associated equipment.
5) Upon "AUTOMATIC /STOP" command, system shall shut down in order that is reverse of specified start-up order with necessary time delays.
6) As part of start-up sequence, operations personnel will be responsible for disabling cake thickness monitoring switch by placing selector switch at belt filter press panel in "DISABLE" position. After "AUTOMATIC/START" cycle is complete and cake thickness and feed rates have been verified, operations personnel will enable cake thickness monitoring switch via the belt filter press control panel. Once enabled, PLC shall shut down belt filter press and associated equipment system upon loss of cake detected by cake thickness monitoring switch.

c. Interlocks: The following interlocks shall be satisfied when control mode selector switch is in either "AUTOMATIC" or "MANUAL" position. Failure of any one signal during start cycle or after cycle is complete shall shut down all associated belt filter press equipment.
    1) Sludge cake conveyor servicing the belt filter press shall be operating and confirmed by the run status signal.
    2) Hydraulic system pressure shall be confirmed by pressure switch. Hydraulic unit, if applicable, for each belt filter press shall started at beginning of cycle with subsequent check of fluid pressure by PLC.
    3) Wash water pump must be running.
    4) Belts on the belt filter press must be properly aligned as detected by misalignment switches.
    5) Control mode selector switch shall be in "AUTOMATIC" position.
    6) Belt filter press safety pull cord switch shall be reset and in operating position.

7) "EMERGENCY STOP" pushbutton shall be in operating position. "EMERGENCY STOP" pushbutton shall be hardwired directly to starters of all motor drives of the associated belt filter press system and to PLC for interlocking.

7. Sludge Feed Pumps Control Strategy:

a. Each Pump and a Grinder shall operate as two separate duty and standby pairs, with only one pair running at a time. Manual valving shall be required for chosen pair selection. BFP shall be serviced by the running Pump/Grinder to transfer sludge from the Sludge Holding Tank. Duty selection for the pair shall be made on the BFP Remote I/O control panel OIT after correctly setting valves in the field.

b. Both Sludge Feed Pumps shall be provided with VFDs with following controls:

1. Start/Stop, Reset, E-Stop Pushbuttons
2. L/O/R and Speed Selector Switch
3. ON, Overload Alarm, High Pressure Alarm, Low Pressure Alarm, and VFD Fail indicating lights
4. Speed Indication

c. Each Sludge Feed Grinder shall be provided with a Local Station with following controls:

1. Forward/Off/Reverse and L/O/R selector switches
2. Run, Power ON, Jammed and Overload indicating Light

d. Control shall be based on the LOCAL/OFF/REMOTE (L/O/R) switch selection:

1. In Local, pumps and grinder shall be controlled from the Start/Stop push buttons and Speed Control Switches. Hardwired interlock shall run the Grinder simultaneously with the pump.
2. In Off, for both pumps and grinders operation shall be prevented in any mode.
3. In Remote, Sludge Feed Pumps and Grinder shall be controlled by the BFP PLC via Remote I/O Panel.
   a. Duty Sludge Feed Pump & Grinder shall be called to run if CP-BFP request to start the sludge pumping. Control the pump speed from CP-BFP control panel based on the flow going to the BFP.

e. If duty pumps fail, "Feed pump Not available for BFP" alarm shall be generated.

f. High or Low Pressure shall stop the feed pump and prevent operation. Further operation of the pump will require manual reset of the lockout relay within the VFD by pressing the Reset push button.

g. E-stop shall stop respective pumps and prevent operation. Further operation will require manual reset of the lockout relay by pressing the Reset push button.

h. Grinder shall be hardwired interlocked with its respective pump and run simultaneously when the Sludge Feed Pump is running.

8. BFP Control Panel Operator Interface Terminal minimum requirements:
   a. Display - 12.4-inch Active Matrix Color TFT, 640 x 480, 18-bit Color, analog touch screen.
   b. Field replaceable backlight.
   c. Memory - Available flash: 64MB; RAM: 64MB.
   d. Communication - Ethernet, RS-232.
   e. Input Voltage - 18-32 VDC.
   f. Power Consumption - 70 watts (maximum).
   g. Operating Temperature - 0 to 55 degrees C.
   h. Humidity - 5-90 percent without condensation.
   e. Rating - NEMA 3R/12, UL-listed.
   j. Product and Manufacturer: PanelView Plus 7 1250, as manufactured by Allen-Bradley or equal.

2.6 SOURCE QUALITY CONTROL

A. Belt Filter Presses:
   1. Upon completion of manufacture of each belt filter press and associated appurtenances, conduct manufacturer's standard shop tests on each factory-assembled belt filter press unit prior to shipment. Shop tests shall be conducted using products to be provided for the Project, including job motors.
   2. Defects revealed during tests shall be corrected or replaced and the products retested until satisfactory results are achieved. Do not ship equipment from the shop until tests are satisfactorily completed and test report accepted by ENGINEER.

B. Belt Filter Press Control Panels: Test per requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which products are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected. Verify that structures, pipes, and equipment are compatible.

3.2 INSTALLATION

A. Install products in conformance with Laws and Regulations, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.

B. Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, per equipment manufacturer's recommendations and the Contract Documents.
   2. Provide concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted thereon shall then be accurately shimmed to grade and spaces between filled with non-shrink grout per Section 03600, Grout. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2-inch.

C. General:
   1. Perform all drilling and fitting required for installation. Set products accurately in location, alignment, and elevation, plumb, true, and free of rack.
   2. Fit exposed connections accurately together to form tight hairline joints.
   3. For contact surfaces between aluminum and dissimilar surfaces, use a coat of bituminous paint or other approved insulating material.
   4. Provide utility connections per the Contract Documents.
   5. Align and adjust equipment including shafting, motors, belts, drives, chutes, and drains in presence of ENGINEER.
   6. Provide appropriate mounting brackets for field instruments, and coordinate location of sensors and transmitters.
   7. Prior to energizing electric motor drive equipment, rotate drive motor by an external source to demonstrate free operation of all mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.

D. Install the hydraulic system units per manufacturer's recommendations.

E. Field painting shall conform to Section 09900, Painting.

F. Comply with Section 01650, Facility Startup.

3.3 FIELD QUALITY CONTROL

A. General.
   1. Following installation, CONTRACTOR and qualified field service representative of Supplier shall conduct operating tests of all equipment, functions, and controls at the Site in presence of ENGINEER.
   2. Conform to Section 01410, Testing Laboratory Services.

B. Process Performance Testing:
   1. Contractor shall supply polymer required for startup and performance testing. Contractor shall arrange for a polymer sales representative to visit the site and provide recommendation for polymer to be used.

2. Equipment shall dewater sludge produced by OWNER's operations at the Site. Sludge to be provided to belt filter presses provided may vary somewhat from sludge having the characteristics described in this specification.
3. Acceptance test will be scheduled jointly by CONTRACTOR and OWNER and will be conducted for eight continuous hours per day for a minimum of three consecutive days. All testing will be supervised by OWNER's personnel.
4. Testing will be during wet weather events, when sludge is being generated and will consist of one day for polymer dosage and operational optimization and two days of intensive testing. At least two test runs shall be conducted during the intensive testing, results of which will be used by ENGINEER for evaluating equipment performance. Continuous eight-hour or longer test run will be conducted each day of intensive testing. Working hours for process performance testing will correspond to wet weather events at the Site.
5. Samples of sludge feed, sludge cake, wash water, and filtrate shall be taken at end of each hour of eight-hour test runs. Supplier may request that two additional sets of samples be taken at any time during the last two hours of test run. Average results of samples taken during each test run will be used for representing performance during test run.
6. Test information required for each test run is as follows:
    a. Test run number.
    b. Sludge feed rate in gpm.
    c. Percent dry solids of feed sludge.
    d. Percent dry solids of sludge cake.
    e. Percent water removed.
    f. Percent solids capture.
    g. Filtrate dry solids in mg/L.
    h. Wash water dry solids in mg/L.
    i. Polymer feed rate in gpm.
    j. Polymer type, activity, and solution feed concentration.
    k. Polymer consumption in active pounds of polymer per dry ton of feed sludge.
7. OWNER's personnel will be responsible for collecting, marking, and delivering samples to Site laboratory for testing by OWNER's personnel. Percent solids in sludge feed and cake samples will be determined as total residue dried at 103 to 105 degrees C in accordance with *Standard Methods for Examination of Water and Wastewater*. OWNER's personnel will assist CONTRACTOR during polymer optimization period by performing tests for sludge, wash water, and filtrate solids on hourly samples. CONTRACTOR will have continuous access to results of laboratory tests conducted on samples during intensive testing as necessary to determine need for adjustments to polymer or sludge feed, or to equipment. Results on samples taken during final three hours of a test run may not be available until the following day. CONTRACTOR may, for its own use and at its option, obtain split samples during test run and utilize services of commercial laboratory acceptable to OWNER for obtaining additional test results. ENGINEER and CONTRACTOR will have access to the test results prepared by OWNER's personnel within three working days of end of intensive testing.

8. CONTRACTOR shall use the average feed sludge consistency during run for reporting. CONTRACTOR shall construct curves representing feed sludge percent dry solids versus cake percent dry solids, and feed sludge percent dry solids versus polymer dosage for each throughput rate. Average values of percent dry solids and polymer dosage for each test run shall be used to plot curves.
9. Rates of unconditioned sludge feed to belt filter press and polymer added to feed sludge shall be measured and recorded during the test when samples are taken.
10. Standpipes or overflow weirs are not allowed in wash water and filtrate drainage sump. Drains shall run free and clear.
11. Recycling filtrate to sludge polymer conditioner is not allowed during testing.
12. Upon completing testing, ENGINEER will evaluate test results relative to belt filter press throughput rate, polymer usage, solids capture, and sludge cake dry solids, and determination whether conformance of each belt filter press with specified process performance has been achieved. ENGINEER's determination will be based on average performance of each belt filter press during the intensive testing. Average process performance for each belt filter press will be estimated on basis of total quantities of water and solids processed by each belt filter press during intensive testing. If ENGINEER determines that dewatering equipment meets specified performance requirements, equipment performance will be acceptable and CONTRACTOR and OWNER will be notified accordingly.
13. ENGINEER will notify CONTRACTOR and OWNER if any belt filter press fails to meet specified performance. Second test will be allowed for units that failed the first test. Initiate the second test within 30 days of being notified of results of first performance test. Conduct second test per test procedure described above.
14. Upon completing second test, ENGINEER will evaluate test results and notify CONTRACTOR and OWNER regarding equipment conformance with specified performance. If second test results indicate that equipment does not meet specified performance criteria, CONTRACTOR and Supplier shall repair, modify, or replace defective equipment. Additional testing of equipment that has been repaired, modified, or replaced shall be conducted per procedure specified above. Compliance with specified performance requirements shall be achieved for equipment to be acceptable unless nonconformance is allowed through payment of performance damages.
15. Satisfactory completion of process performance testing does not release CONTRACTOR from obligations under the Contract.

C. Manufacturer's Services: Provide a qualified, factory-trained service technician to perform the following:
   1. Supervise unloading and installation of equipment.
   2. Instruct CONTRACTOR in installing equipment.
   3. Inspect and adjust equipment after installation and ensure proper operation.
   4. Instruct OWNER's personnel in operating and maintaining the equipment.
   5. With CONTRACTOR, perform field testing of equipment.

6. Supplier's representative shall make a minimum of 6 visits, with a minimum of 8 hours onsite for each visit. First visit shall be for unloading supervision and instruction of CONTRACTOR in installing equipment; second visit shall be for assistance in installing equipment; third visit shall be for checking completed installation and start-up of system; fourth visit shall be to instruct operations and maintenance personnel; fifth and sixth visits shall be for field testing. Representative shall revisit the Site as often as necessary until installation is acceptable.
7. Training: Furnish services of Supplier's qualified factory trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and qualifications shall be per Section 01664, Training.
8. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

END OF SECTION

SECTION 11920

CHEMICAL TANK AND PUMP INSPECTION AND REPAIR

PART 1 - GENERAL

1.1 SCOPE

A. Contractor shall have the original equipment manufacturer inspect chemical storage tanks and chemical feed pumps, prepare inspection reports and cost estimates, and perform repairs. Contractor must furnish to the City a document outlining the inspection results and the scope and total cost of the site visit, report preparation, and making the repairs. Costs shall include overhead, profit and appurtenant costs to provide a complete and workable installation. The report and costs shall be approved by the Engineer/City, prior to beginning any repair work.

B. Equipment to be inspected and repaired under this section:

Location	**Equipment Number**
EA WQCF	98T0701, 98T0702, 98T0801
EA WQCF	98P0711, 98P0712, 98P0811, 98P0812
Custer Ave CSCF	T0100, T0200, P1101, P1201

1.2 REFERENCES

Comply with all Federal state laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. Prior to commencement of work the Contractor shall submit a proposed work schedule to the City for all work described in this section.

C. The following shall be submitted to the City for review and approval prior to performing repairs:

1. Manufacturer’s inspection report

2. Quotation for cost of recommended repairs

1.4 QUALITY ASSURANCE

A. FRP Tank Inspection: All work shall be completed by a qualified FRP tank inspector (Inspector) designated or employed by Augusta Fiberglass who

has not less than 5 years experience in the inspection of FRP Tanks designed for corrosion resistance.

B. FRP Tank Repair: Repairs shall be performed by Augusta Fiberglass.

C. Peristaltic Chemical Feed Pump Inspection: Inspection shall be performed by Watson-Marlow.

D. Peristaltic Chemical Feed Pump Repair: Repairs shall be performed by Watson-Marlow.

PART 2 - PRODUCTS

2.1 CHEMICAL COMPATIBILITY

Wetted materials that are repaired or replaced shall be compatible with the process fluid.

2.2 REPLACEMENT PARTS

Replacement parts shall be new and unused.

PART 3 - EXECUTION:

3.1 TANK INSPECTION

A. Pre-inspection

The tank must be cleaned, neutralized, dry, and ventilated by Contractor prior to arrival by Inspector. The tank must be environmentally safe for entry without the use of a respirator. The manway cover must be removed by Contractor.

B. Inspection

Inspector shall provide a minimum of one tank inspector and one assistant to inspect the FRP vessel(s) in order to monitor the condition and integrity of the vessel, and determine if the equipment needs repair. Any imperfections, defects, cracks, delamination, problem areas, and concerns shallll be located and photographed. Recommended repairs shall be documented in a written report and submitted to the City Engineer.

C. Contractor Responsibilities

1. Contractor shall supply all necessary electricity to the jobsite at 110 volts.
2. Contractor shall make the job available and accessible to the inspector for work at any hours that are deemed necessary by the

inspector to carry out the project in the project's best interest (including night, holidays, weekends, etc.).

3. Contractor is to remove any obstacles that will hinder the work operation.
4. Contractor shall be responsible for the supervision of the safety techniques and procedures of any of its personnel working at or near the jobsite. Inspector shall remain solely responsible for the safety of its own employees, but disclaim responsibility of the supervision of non-inspector personnel.
5. Contractor shall be responsible for any fees, licenses, permits, etc. required for the job.
6. Contractor shall furnish trash containers in the immediate area of the job for trash and waste generated during the job, and dispose of same.
7. Contractor shall provide a non-hazardous safe work environment and shall provide the following:
    a. Clean and check for chemical residues and fumes.
    b. Lock out and tag at all inlets, outlets, nozzles, mechanical equipment and electrical equipment associated with tank or repair area.
    c. Check oxygen content for safe entry. (Inspector will perform Confined Space procedures or go in under Contractor's permit.)
    d. Perform any requirements in accordance with any Plant Safety Regulations and/or OSHA requirements.
    e. Any site specific safety equipment needed to enter the jobsite (inclusive of special respirators, protective clothing, lighting, etc.)
    f. Adequate fresh air ventilation inside vessel.
    g. Any site or local safety guidelines, regulations, or training.
    h. Any ladders, scaffolding, cranes, etc. required.
    i. Adequate lighting inside the vessel.

3.2 PUMP INSPECTION

A. Pre-Inspection

The pump must be cleaned, neutralized, and dried by Contractor prior to arrival by Inspector.

B. Inspection

Inspector shall provide a minimum of one pump inspector to inspect the pump in order to determine if the equipment needs repair. Any cracked or broken components, problem areas, and concerns shall be located and photographed. Recommended repairs shall be documented in a written report and submitted to the City Engineer.

C. Contractor Responsibilities

1. Contractor shall supply all necessary electricity to the jobsite at 110 volts.
2. Contractor shall make the job available and accessible to the inspector for work at any hours that are deemed necessary by the inspector to carry out the project in the project's best interest (including night, holidays, weekends, etc.).
3. Contractor is to remove any obstacles that will hinder the work operation.
4. Contractor shall be responsible for the supervision of the safety techniques and procedures of any of its personnel working at or near the jobsite. Inspector shall remain solely responsible for the safety of its own employees, but disclaim responsibility of the supervision of non-inspector personnel.
5. Contractor shall be responsible for any fees, licenses, permits, etc. required for the job.
6. Contractor shall furnish trash containers in the immediate area of the job for trash and waste generated during the job, and dispose of same.
7. Contractor shall provide a non-hazardous safe work environment and shall provide the following:
    a. Clean and check for chemical residues and fumes.
    b. Lock out and tag at all mechanical equipment and electrical equipment associated with pump or repair area.
    c. Perform any requirements in accordance with any Plant Safety Regulations and/or OSHA requirements.
    d. Any site specific safety equipment needed to enter the jobsite (inclusive of special respirators, protective clothing, lighting, etc.)
    e. Any site or local safety guidelines, regulations, or training.
    f. Any ladders, scaffolding, cranes, etc. required.

+ + + END OF SECTION + + +

DIVISION 12

FURNISHINGS

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SECTION 12680
PRE-ENGINEERED FIBERGLASS BUILDINGS

PART 1 - GENERAL

1.1 SCOPE

Work required under this section consists of providing all design, labor, equipment, materials and services required to furnish, erect and install one pre-engineered fiberglass building on the site as shown on the Contract Drawings and/or specified herein.

1.2 GENERAL REQUIREMENTS

A. Building is identified in Contract Documents and shall be of nominal dimensions as indicated in the Contract Documents.

B. The building shall be one-piece molded construction fiberglass pre-fabricated buildings so designed and constructed as to be weathertight, easily erected, and capable of being dismantled and re-erected. The building shall be the product of a manufacturer who is regularly engaged in the fabrication of pre-engineered fiberglass structures.

C. Building components shall consist of interior and exterior laminate walls, interior core, doors, ventilation fans and louvers, exhaust fan thermostat, heater, light fixture and switch, circuit breaker panel, trim, fasteners, accessories, and miscellaneous items required for a complete prefabricated fiberglass building.

D. The nominal building width shall be measured from outside to outside of exterior surfaces.

E. The building eave height shall be measured from the top of the interior sidewall to the bottom of the internal mounting flange.

1.3 RELATED SECTIONS

A. Section 01600, General Material & Equipment Requirements

B. Section 03300 – Cast-in-Place Concrete

C. Section 08710 – Finish Hardware.

D. Section 11000, General Requirements for Equipment

E. Division 16, Electrical

F. Section 17275, Miscellaneous Panel Instruments

1.4 SUBMITTALS

A. Submit shop drawings for Instrument Cabinet for Sample Point No. 1 (Reference Drawing M-020).

B. Design Certification
   1. All bidders must submit with their bid proposal, a letter from the building manufacturer certifying that the proposed building will meet or exceed all design load criteria and that all structural design will be in strict conformance with the International Building Code 2012 with Georgia 2014, 2015 Amendments.
   2. After award of the Contract, a complete structural analysis of both building and foundation bearing the seal of a registered Professional Engineer in the State of Georgia shall be submitted by the manufacturer to the Engineer. All reactions for the proper design of foundations shall be supplied by the building manufacturer to the Engineer.

C. Shop Drawings
   1. Prepare and submit complete shop drawings for materials to be provided under this section. Refer to General Conditions-28, Working Drawings, Shop Drawings, Data on Material and Equipment, Samples and Licenses, for directions for preparation and submission. Provide the following at a minimum for each building:
      a. Critical dimensions, jointing and connections, fasteners and anchors.
      b. Materials of construction.
      c. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.
      d. Product Data: Certified independent test results of representative wall laminate.
      e. Calculations and drawings: Structural design calculations, sealed by an independent licensed Professional Engineer.
      f. Installation Drawings: Drawings shall be furnished to clearly show the locations of all components and parts for identification and assembly of the structure.
      g. Submit complete printed Manufacturer's installation instructions.
      h. Bill of materials
      i. Certification of correct installation.

   2. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the General Conditions-28, Working Drawings, Shop Drawings, Data on Material and Equipment, Samples and Licenses, to include but not be limited to the following:

a. Materials/components characteristics and engineering data and layout and installation requirements.
b. Electrical equipment and power and controls wiring diagrams.
c. Control narrative.
d. Bill of materials and spare parts.
e. Equipment O&M manual
f. Performance affidavit
g. A description of the manufacturer's warrantee to be provided
h. Field test reports
i. Certification of correct installation and operation

D. Samples
Submit color samples for approval by the Engineer in accordance with the General Conditions-28, Working Drawings, Shop Drawings, Data on Material and Equipment, Samples and Licenses. No products or materials shall be ordered until color samples have been approved by the Engineer.

1.5 REFERENCES

A. ASTM C 518 – Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

B. ASTM D 256 – Standard Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

C. ASTM D 618 – Standard Practice for Conditioning Plastics for Testing.

D. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.

E. ASTM D 732 – Standard Test Method for Shear Strength Plastics by Punch Tool.

F. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

G. ASTM D 792 – Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.

H. ASTM D 1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics.

I. ASTM D 2583 – Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

1.6 MANUFACTURERS

The building shall be the product of a manufacturer who is regularly engaged in the fabrication of pre-engineered structures conforming to the standards. Acceptable manufacturers are:

A. TRACOM, Inc., Alpharetta, GA

B. Warminster Fiberglass Company, Southampton, PA

C. or equal

1.7 DESIGN CRITERIA

A. The building manufacturer shall submit a letter of certification describing his design responsibility, design calculations, compliance with all applicable codes, etc. This submittal shall be made to the Engineer at time of shop drawing submittal in accordance with General Conditions, Section 28.

B. Size: provide one-piece molded construction FRP building(s) of the following dimensions:
4 Feet-0 Inches Deep x 6 Feet-0 Inches Wide x 7 Feet-0 Inches High.

C. All loads and combination of loads for purposes of designing structural members shall be as prescribed in the IBC 2012 but not less than the following normal design loads:
1. Wind Load:
120 miles per hour wind load
2. Snow Load:
5 pounds per square foot snow load

1.8 GUARANTEE

Provide a guarantee against defective or deficient products and workmanship in accordance with requirements of General Conditions-22, Guarantee of Work and Materials. Roof and wall color finishes shall be guaranteed for a period of not less than 10 years.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

The buildings shall be provided with a smooth interior and exterior satin finish. The walls and roof shall be integral with smooth radii for all corners. No roof overhang shall be allowed. External flanges shall only be allowed in those instances where the building is oversized.

2.2 LAMINATE

A. Isophthalic polyester resin with high performance, chopped, commercial grade glass strand fiber reinforcement with a suitable coupling agent.

B. Minimum glass content: 30%.

C. Exterior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a satin finish lightly textured and free from fiber pattern, roughness, or other irregularities.

D. Exterior laminate: 1/8 inch thick (minimum); chemically bonded to the surface gel coat and encapsulating the foam core.

E. Interior laminate: 1/8 inch thick (minimum); chemically bonded to the interior gel coat and encapsulating the foam core.

F. Interior surface: 15 mil (minimum) gel coat with U.V. inhibitors and a textured finish, free from exposed glass or other irregularities.

G. Laminate properties:
   1. Tensile strength (ASTM D 638): 14,000 PSI.
   2. Flexural strength (ASTM D 790): 27,000 PSI.
   3. Flexural modulus (ASTM D790):1,000,000 PSI.
   4. Shear strength (ASTM D 732): 12,000 PSI.
   5. Barcol hardness (ASTM D 2583): 40.
   6. Density / specific gravity (ASTM D 792): 93.6 PCF/1.5.

2.3 FOAM CORE

A. Rigid closed cell, self-extinguishing (Class 1), polyisocyanurate foam with a density of 2.3 pounds per cubic foot. Foam shall be T250 Elfoam without exception. 1 inch thick with a minimum core insulating value of R~7.

B. Core properties:
   1. Thermal conductivity (ASTM C 518): 0.145 BTU inch/hr./SF/°F.
   2. Density / specific gravity (ASTM D 1622): 2.3 PCF.
   3. Shear Strength (ASTM C 273): 25 lb/in^2
   4. Tensile Strength (ASTM D 1623): 45 lb/in^2
   5. Compressive Strength (7% deflection/yield) (ASTM D 1621): 35

2.4 COMPONENTS

A. Doors
   1. Provide one single-door assembly for each building. Door shall be on the 6-foot wide wall.
   2. Construction (each door):

a. One-piece molded fiberglass construction 78 inches high, 1-3/4 inches thick, and 36 inches wide.
b. Mount door with two T-304 stainless steel laminated strap hinges, 5 inches long. Continuous piano hinges or the use of fastening methods other than bolting shall not be acceptable.
c. Rubber bulb gasket with flexible lock to retain permanent grip.
d. One-piece, purpose built, 3 inches deep fiberglass drip cap over doors; drip cap to extend 2 inches each side past door. Cut angle shall not be acceptable.
e. Full threshold, heavy duty black vinyl, 4-1/2 inches deep x 1/2 inch high.
f. Schlage stainless steel single-point, key locked, lever style knob. To facilitate entry and exit from the building, raised door sills shall not be acceptable. Key cores to match key cores on other doors on the project. Door shall be a part of the keying system for the rest of the project.
g. Heavy duty stainless steel, dual compression spring cushioned overhead door stop, designed for BHMA L52231 and ANSI A156.16.
h. Provide single-flap neoprene insert style door sweep.

B. Lifting Eyes: Provide a minimum of two removable, 3/4 inch – 10 partially threaded, eye bolts with 6-inch shank lengths.

C. Steel (5,200 lbs. work load limit).

D. Mounting Flange: Provide internal flange 3 inches wide x 1/4-inch-thick (minimum) with closed cell neoprene sponge rubber gasket 2 inches wide x 3/8-inch-thick to provide a weather tight seal around the building perimeter.

2.5 ELECTRICAL

A. Circuit Breaker Panel: 120 / 240 VAC, 1 phase, surface mount. 125-amp, main lug, 8 branch, NEMA 1 metallic body. Lighting, receptacles, fan, heater and all electrical devices shall be pre-wired to the distribution/circuit breaker panel.

B. Electrical Wiring: 12 gauge stranded, color-coded THHN/THWN/MTW electrical wiring in rigid, U.L. listed, corrosion / impact resistant, non-conductive, Schedule 40 PVC conduit. SO cord or other non-encased wiring shall not be acceptable.

C. Receptacle: Interior GFCI receptacle 15A 125V, 20 A 125V feed-through, with 5mA +/- 1mA trip threshold.

D. Switch: Single toggle, for light in weatherproof switch box.

E. Interior Light: Lamp to be wired to the weatherproof light / fan switch. 64 watt, 2-bulb, 48-inch fluorescent vapor-tight fixture with acrylic lens for damp locations

2.6 VENTILATION

A. Fan: Shutter-mounted exhaust fan with integral gravity shutter, aluminum fan blades, fiberglass canopy, and OSHA compliant polyester-coated wire guard. Exhaust fan to be wired to the weatherproof light / fan switch. 585 CFM 10-inch diameter fan.

B. Heater: Line powered wall heater. No separate electrical outlet shall be required. 2,000 watt, 6,124 BtuH, 240 VAC, white powder coat finish with automatic re-set thermal overload protection with indicator light and built-in thermostat.

C. Shutter: Gravity operated fiberglass intake shutter, with heavy duty fiberglass frame and exterior removable T-316 stainless steel insect screen, 10 inches by 10 inches.

D. Thermostat: NEMA 4X electric line voltage thermostat for remote operation of fan, 0-45 C and 30-110° F.

PART 3 - EXECUTION

3.1 GENERAL

Install and erect the buildings in accordance with approved shop/erection drawings and manufacturer's printed instructions. Anchors shall be supplied by the Contractor per the manufacturer's recommendation.

3.2 INSPECTION AND APPROVAL

A walk-through inspection shall be conducted after completion of all work.

3.3 CLEANING

At the completion of this work, remove from the site all excess materials and debris. Leave entire work in a neat and workmanlike condition ready for the Engineer's inspection. Coordinate with section titled "Cleanup" of these Specifications.

3.4 PROTECTION

Protect all work of this Section until final acceptance of the work by the Owner.

++ END OF SECTION ++

DIVISION 13

SPECIAL CONSTRUCTION

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SECTION 13125

PRE-ENGINEERED METAL BUILDING

PART 1 GENERAL

1.1 SCOPE

A. Work required under this section consists of providing all labor, equipment, materials and services required to furnish, erect and install the pre-engineered steel building on the site as shown on the Contract Drawings and/or specified herein.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the metal building systems.
   2. Notify other Contractors in advance of the installation of the metal building systems to provide them with sufficient time for the installation of items that must be installed with, or before, the metal building systems.
   3. Coordinate the locations of equipment, piping, heating and ventilating ductwork, electrical conduit and similar items in order to provide required clearances and supports for such items without modification of metal building system components at the Site.

C. Related Sections:
   1. Section 03300, Cast-in-Place Concrete.
   2. Section 07900, Calking and Sealants.
   3. Section 08331, Overhead Rolling Doors.
   4. Section 08513, Aluminum Windows.
   5. Section 08710, Finish Hardware.
   6. Section 08800, Glass and Glazing.
   7. Section 09900, Painting.
   8. Section 10200, Louvers.
   9. Section 15750, Electric Make-up Air Handling Units
   10. Section 15870, Power Ventilators

1.2 GENERAL REQUIREMENTS

A. Building is identified as the Sludge Dewatering Building and shall be of nominal dimensions shown on the Contract Drawings.

B. The building shall be rigid frame pre-fabricated steel building so designed and constructed as to be weathertight, and easily erected. The building shall be the product of a manufacturer who is regularly engaged in the fabrication of pre-

engineered structures conforming to the Metal Building Manufacturers Association's (MBMA) standards.

C. Building components shall consist of all columns, rafters, struts, purlings, girts, connectors, bracing, base clip, wall and roof panels, flashing, gutters downspouts, trim, fasteners, accessories, and miscellaneous items required for a complete prefabricated steel building.

D. The nominal building width shall be measured from outside to outside of framing.

E. The building eave height shall be measured from the top of the eave strut at the sidewall steel line to the bottom of the rigid frame column baseplate.

F. The bay spacing shall be measured from the centerline to centerline of the rigid frame or to the end wall steel line for end bays.

1.3 QUALITY ASSURANCE

A. Building Manufacturer Qualifications:

1. Engage a manufacturer specializing in the production of the types and quality of products specified and with a documented record of successful in-service metal building system performance.
2. Manufacturer shall be a member of MBMA and be certified by AISC as a manufacturer that designs and produces metal building systems in a AISC-Certified Facility.
3. The manufacturer shall be able to demonstrate experience with providing complete technical services including preparation and review of Shop Drawings, including installation methods and detailing for metal building system components. Where the manufacture requires additions, or changes to the contract Documents in order to facilitate its design and fabrication of system components, these shall be made at no additional cost to the owner.
4. Acceptable manufacturers are: Star Manufacturing Company; Butler Manufacturing Company; American Buildings Company or equal.

B. Erector Qualifications:

Engage a single erector skilled, trained and with successful and documented experience in the installation of metal building systems who is acceptable to the metal building system manufacturer, and with specific skill and successful experience in the erection of the types of components required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualification to engineer along with the following information on a minimum of three successful projects:

1. Names and telephone numbers of owner, architects or engineers responsible for projects.
2. Approximate contract cost of the metal building system.
3. Amount of area installed.

C. Professional Engineer:

1. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated.
2. Responsibilities include, but are not necessarily limited to, the following:
   a. Carefully reviewing system performance and design criteria stated in the Contract Documents.
   b. Preparing written requests for clarification or interpretation of performance or design criteria for submittal to engineer by contractor.
   c. Preparing, or supervising the preparation of design calculations, and reviewing and approving related Shop Drawings prepared by the metal building system manufacturer prior to submission to engineer; and providing comprehensive engineering analyses verifying compliance of the system with the requirements of the Contract Documents.
   d. Signing and sealing all calculations and engineering analyses.
   e. Certifying that:
      1) it has performed the design of the system in accordance with the performance and design criteria stated in the Contract Documents, and
      2) the said design conforms to all applicable local, state and federal codes, rules and regulations and to the prevailing standards of practice.

D. Erection and Location Tolerances:

1. Comply with MBMA's "Low Rise Building Systems Manual," Chapter IV, Section 9, "Fabrication and Erection Tolerances."
2. Structural-Steel Erection Tolerances: Comply with erection tolerance limits of AISC S303, "Code of Standard Practice for Steel Buildings and Bridges."
3. Roof Panel Installation Tolerances: Shim and align units within installed tolerance as follows:

   Slope and Location: 1/4 inch in 20 feet on lines as indicated, and within 1/8-inch offset of adjoining faces and alignment of matching profiles.
4. Wall Panel Installation Tolerances: Shim and align units within installed tolerances as follows:

   Level and Plumb: 1/4 inch in 20 feet on location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
5. Door Installation Tolerances: Fit doors in frames within clearances specified in SDI 122.

1.4 SUBMITTALS

A. Design Certification

1. All bidders must submit with their bid proposal, a letter from the building manufacturer certifying that the proposed building will meet or exceed all design load criteria and that all structural design will be in strict conformance with Metal Building Manufacturer’s Association “Design Practices Manual.”

2. After award of the Contract, a complete structural analysis of both building and foundation bearing the seal of a registered Professional Engineer shall be submitted by the manufacturer to the Engineer. All reactions for the proper design of foundations shall be supplied by the building manufacturer to the Engineer.

B. Shop Drawings
Prepare and submit complete shop drawings for materials to be provided under this section. Refer to section titled "Submittals" of these Specifications for directions for preparation and submission.

C. Samples
Submit color samples for approval by the Engineer in accordance with section titled "Submittals" of these Specifications. No products or materials shall be ordered until color samples have been approved by the Engineer.

D. Erection Drawings
Drawings shall be furnished to clearly show the locations of all components and parts for identification and assembly of the structure. Also submit complete printed erection instructions.

1.5 DESIGN CRITERIA

A. The building manufacturer shall submit a letter of certification describing his design responsibility, design calculations, compliance with all applicable codes, etc. This submittal shall be made to the Engineer at time of shop drawing submittal in accordance with section titled "Submittals" of these Specifications.

B. Standard Specifications and Codes
1. AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings, latest edition, for all structural steel sections or welded-up plate sections.
2. AISI Specifications for the Design of Cold-Formed Steel Structural Members, latest edition, for cold formed steel structural members.
3. American Welding Society "Code for Welding in Building Construction."
4. Metal Building Manufacturer's Association Recommended Design Practice Manual.
5. International Building Code 2012, with applicable Georgia Amendments.

C. All loads and combination of loads for purposes of designing structural members shall be as prescribed in the Southern Standard Building Code but not less than the following normal design loads:
1. Wind Load
90 miles per hour. (ALLOWABLE)
120 miles per hour. (ULTIMATE, ASCE 7-10)

Risk Category: III
Wind Exposure: C

2. Roof Live Load
   ~~2~~30 pounds per square foot minimum on the horizontal projections of the structure, both purlings and frames.
3. Auxiliary Loads
   All other applicable superimposed dynamic and/or static loads shall be considered as part of the overall design requirements and combined with the normal design loads.
4. Combination of Loads
   Combining normal loads and auxiliary loads for design purpose shall be as prescribed by the Metal Building Manufacturers Association "Recommended Design Practices Manual."

D. Design shall be on the basis of elastic behavior.

E. Minimum yield strength for cold-formed steel shall be 55,000 psi.

F. Minimum yield strength for brace rods shall be 36,000 psi.

G. All other steel shall have minimum yield strength of 50,000 psi.

H. Energy Efficiency
   1. U-Values
      a. Roofs – U-0.035
      b. Walls – U-0.079
   2. R-Values
      a. Roofs – R-19 + R-11LS
      b. Walls – R-13 + R6.5ci
      c. Slab-on-grade – Not required.
      d. Opaque Doors – Swinging = U-0.61, Roll-Up = R-4.75

1.6 GUARANTEE

Provide a guarantee against defective or deficient products and workmanship in accordance with requirements of section titled "Warranties and Bonds" of these Specifications. Roof and wall panel color finishes shall be guaranteed for a period of not less than 20 years. Written copies of the guarantees shall be submitted to the Engineer for review. Final copies shall be given to the Owner at the time of acceptance of the building.

PART 2 PRODUCTS AND MATERIALS

2.1 GENERAL

All materials shall be completely fabricated and prepared for shipment knocked down including any necessary crating or handling provisions. All parts of the building are to be accurately made and true to dimension so that in erection, all parts will easily fit together.

2.2 PRIMARY FRAMING

A. The frame shall be clear span, rigid frame, with uniform depth columns and tapered beams of continuously shop-welded steel plates. Frame members shall be provided with necessary splice members and shop fabricated plates complete with connection bolt holes for complete field assembly.

B. Members shall have holes in web and/or flanges for the attachments of secondary structural members.

C. End frames shall have same uniform depth columns and rafters as intermediate frames.

2.3 SECONDARY FRAMING

A. Purlings and girts shall be manufacturer's standard precision rollformed "Z" shapes for service and loads indicated.

B. Panels shall be connected to purlings and girts using self-drilled fasteners with long life heads.

C. Eave struts shall be manufacturer's standard "C" shapes for service and loads indicated.

D. Wall and roof bracing shall be designed and placed with the necessary washers and nuts to resist specified design loads.

E. Flange braces, sag angles, sag rods, anchor bolts, etc., shall be provided as required.

F. Base angle shall be attached to the foundation according to the pre-engineered building manufacturer's standard so as to provide a weathertight and neat appearance.

G. Portal frame columns and beams shall be shop fabricated complete with holes in the webs, flanges, cap plates, splice plates and baseplates for field-bolted assembly.

2.4 CONNECTIONS

A. All anchor bolts shall be of black steel having a minimum yield point of 43,300 psi, unpainted and of proper size to adequately resist all applicable design loads at the base

of columns and frames. Anchor bolts shall be furnished and set according to the dimensions and locations as specified by the building manufacturer. Consult the manufacturer's shop drawings for projection, location and /or spacing of these anchor bolts. The foundation contractor shall provide and install anchor bolts of the size and location, approved by the metal building manufacturer.

B. All high-strength bolts shall be plated steel and shall conform to specifications for Steel Machine Bolts and Nuts and Tap Bolts, ASTM A 325. In addition, all bolts, washers, and nuts shall be electro-galvanized conforming to ASTM A 164. A chromate conversion treatment shall be applied over the protective zinc coating in preparation for finish coat.

C. All other bolts, nuts and tap bolts shall be in accordance with specification ASTM A 307 and shall be electro-galvanized conforming to ASTM A 164. In addition, a chromate conversion treatment shall be applied over the protective zinc coating.

D. All sheet metal screws and/or self-drilling screws shall be class #410, stainless steel conforming to Federal Specification QQ5763C.

2.5 PAINTING

A. The primary structural members shall be suitability cleaned to receive primer coat. Visible grease and oil shall be removed using solvent, in accordance with SSPC-SP1. Members shall be cleaned of rust, mill scale, and other foreign matter using shot-blast cleaning per SSPC-SP6, prior to painting. The specified coating system shall be furnished and applied in accordance with the painting system schedule in Section 09900, Painting.

B. Structural steel shall receive shop applied primer coat with field touch-up. Finish coats shall be field applied. Final finish color shall match interior panels.

C. All structural steel shall receive all coats of the painting system prior to the installation of building HVAC, electrical, mechanical, plumbing, piping, or equipment, unless otherwise approved by the engineer.

D. Secondary structural materials shall be pre-painted in the shop.

E. Clip and angles shall be cleaned and painted per Section 09900, Painting.

F. Painting of all interior and exterior surfaces as required in these specifications and/or on the Contract Drawings shall be complete before final acceptance by the Owner.

2.6 ROOF AND WALL PANELS

A. The roof and wall panels shall be manufacturer's standard "sandwich" panel consisting of a 26-gauge corrugated panel on the exterior and smooth surfaced 26-gauge interior panel. Insulation between the panels shall be polyurethane foam with a "U" value no greater than 0.079 BTU/hr./sq. ft./°F. The panels shall have appropriate joiner members and factory-applied sealant on all endlaps and sidelaps.

B. The panels shall have side laps of 1 full corrugation, a nominal covering of 3 feet and a nominal thickness of not less than 2½ inches.

C. Roof and wall panels will be factory finish and carry a 10-year guarantee against chipping, cracking, blistering or peeling, excessive fading and chalking. Color finishes will have passed the various ASTM tests covering pre-finished panels and will be submitted with the shop drawings. Color to be selected by the Owner.

D. The maximum panel length shall not exceed 32 feet.
   1. Wall panels shall be 1-piece from base to building eave.
   2. Any openings in panels for doors and windows shall be provided so as to use only 1-piece above heads or 1-piece below sills. Horizontal splices in wall panels will not be acceptable.

E. Roof panels shall be factory pre-punched at panel ends.

F. The panel design shall provide for expansion and/or contraction as caused by an ambient temperature range of 120°F without causing harmful buckling, opening of joints that violate the weathertight integrity of the structure and other detrimental effects.
   Any metal-to-metal contact (interior to exterior face) shall be prevented by the use of plastic joiner member which shall also provide a positive connection between the exterior and interior face.

G. Continuous galvanized base angles shall be provided to assure weather-tightness at the sill.

H. All exterior and interior trim shall be prefinished galvalume material.

I. All flashings, trim, closure plates, and similar items shall be as detailed on drawings as supplied by the manufacturer of the building panels.

J. End laps, where they occur, shall be at least 6 inches and fastened together over and to structural members.

K. Fastening of panel-to-panel and panel-to-structurals shall be with Lock-Rivets. Color caps of matching colors shall be applied on the exposed heads of all wall panel side

lap rivets. Panel to Panel connections and Panel or Panel Clips to Structure connections, shall be made with appropriate self-drilling fasteners with pre-punched back up plates for standing seam applications.

L. Fastener spacing shall not exceed 6 inches at end laps. There shall be a minimum of 2 fasteners per linear foot at end laps, i.e., 1 in the flat of the panel between each major corrugation and 1 fastener at each major corrugation.

M. Wall panels shall not be erected until the ambient air temperature has been a minimum of +40°F, the sidelap fasteners should not be installed until the temperature requirements are met (2 hours at +40°F).

N. Provide at least 10 skylight roof panels, with at least 15 square feet of area each, spaced evenly over the building roof area. Refer to drawings for location of skylights. Skylight layout to be coordinated with other disciplines. Manufacturer shall provide skylight dimensions, installation details and signed and sealed calculations for review by engineer. The skylight panels shall be made from a 2 ounce per square foot not of high-strength, fibrous glass embedded and saturated in acrylic modified-polyester resins and cured under heat. Panels shall conform to NBS Voluntary Standard No. PS-53-72 Type 1 and have a nominal thickness of 0.06 inch. Metal building manufacturer shall provide properly designed framing for skylight openings.

O. Roof and wall panels shall carry a full replacement durability guarantee of not less than 20 years. Guarantee on roof and wall panels shall be submitted in accordance with the procedures section titled “Submittals” as outlined in these Specifications.

P. Liner panels shall be building manufacturer’s standard solid panels.-Liner panels shall have shallow “V” grooves. Material shall be minimum 26-gauge steel, hot dipped galvanized G-90 with white siliconized polyester finish. Height shall be as indicated on the drawings.

2.7 GUTTER AND DOWNSPOUTS

A. Form from 0.0179-inch thick, zinc coated (galvanized) steel sheet or aluminum zinc alloy coated steel sheet prepainted with coil-coating. Match profile of roof fascia and rake trim.

B. Gutters: Formed in sections not less than 8 feet in length, complete with end pieces, outlet tubes, and all special pieces as shown on the Drawings. Unless otherwise shown, provide expansion-type slip joint at the center of runs. Furnish gutter supports spaced at 36 inches on centers, constructed of same metal as gutters. Provide standard aluminum wire ball strainers at each outlet.

C. Downspouts: Formed from 0.0179-inch thick, zinc coated (galvanized) steel sheet or aluminum zinc alloy coated steel sheet prepainted with coil-coating, in sections

approximately 10 feet long, complete with elbows and offsets. Join sections with minimum 1 1/2 inches telescoping joints. Provide fasteners at top, bottom and at 5 foot centers designed to securely hold downspouts not less than 1 inch away from walls. Finish downspouts to match wall panels.

D. Provide preformed rubber weatherseals to completely fill roof corrugation voids prior to installation of contour gutter.

E. Provide 26-gage galvanized steel closures to close corrugations in wall panels prior to installation of gutters.

F. A 45 degree elbow shall be provided at the base of all downspouts to direct the water flow away from the building.

2.8 VENTILATION

A. Framed openings for ventilators shall be provided as required to properly support ventilators and provide a weathertight installation. Ventilators shall be provided in sizes and locations shown on the Contract Drawings.

B. Louvers shall be of the sizes as shown on the Contract drawings. The louvers shall be of the type as described in Section 10200, Louvers. Flashing and all accessories shall be provided to assure a weathertight installation. Color shall be selected at the time of shop drawing approval.

2.9 DOORS AND WINDOWS

A. Provide the doors and windows as shown on the Contract Drawings or as specified within these Specifications.

B. Doors shall be provided as outlined in Section 08110, Steel Doors and Frames and of the style as indicated on the Contract Drawings. All components of the frame and door are described in Section 08110, Steel Doors and Frames and Section 08800, Glass and Glazing.

C. All door frame structural steel components shall be factory fabricated, sheared, punched, formed, and primed with 1 shop coat of primer as specified in section 09900 Painting.

D. Frame connection assemblies at jamb base, and foundation, jamb and wall girts, jamb and header, and jamb at eave strut shall be U.S. Standard 14-gauge steel clip angle and ½-inch bolts.

E. Clip angle connections shall be ½-inch and shall be cadmium-plated.

F. Anchor bolts shall be ½-inch by 2½-inch bolts with expansion shields or ½-inch anchor bolts embedded in concrete.

G. Provisions shall be made to incorporate into the pre-engineered building an overhead door. It is the responsibility of the pre-engineered building manufacturer to coordinate all details on methods of construction and installation of said doors. These details will be submitted to the Engineer for review and will be approved at the time of shop drawing submittal. See Section 08331, Overhead Rolling Doors, for description.

2.10 ACCESSORIES

A. The building shall be supplied complete with all the required fascia, ridge cover, flashing and other accessories required to provide a complete installation.

B. Provide drip edges above all personnel doors.

C. Accessories shall be provided to give a detailed finish to the building when there is an interference of other trades involvement on the building (i.e., plumbing through roof, ventilation fans, etc.).

D. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet on centers using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

E. Downspouts: Join sections with 1 1/2 inch telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches on centers in between. Provide elbow at base of downspout to direct water away from building.

PART 3 EXECUTION

3.1 GENERAL

Install and erect the buildings in accordance with approved shop/erection drawings and manufacturer’s printed instructions.

3.2 INSPECTION AND APPROVAL

Inspection and approval of the structural system of the prefabricated steel building shall be the responsibility of the building manufacturer. The quality of workmanship for erection shall be the responsibility of the General Contractor. The metal building manufacturer shall furnish a qualified representative to advise the Contractor on erection procedures and problems. Periodic visits to the job site by the metal building representative shall include, but not be limited to, the following:

A. Pre-erection Planning Conference.

B. Erection of rigid frames.

C. Installation of wall and roof panels.

D. Final inspection and written approval by the manufacturer.

3.3 FIELD MODIFICATION OF PARTS

Field modification of parts shall be in accordance with the best standard procedures and shall be the responsibility of the building erector.

3.4 CLEANING

At the completion of this work, remove from the site all excess materials and debris. Leave entire work in a neat and workmanlike condition ready for the Engineer's inspection. Coordinate with section titled "Cleanup" of these Specifications.

3.5 PROTECTION

Protect all work of this Section until final acceptance of the work by the Owner.

++ END OF SECTION ++

DIVISION 14

CONVEYING SYSTEMS

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SECTION 14620
SLUDGE CONVEYORS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install belt conveyor equipment complete and operational.
   2. Included are conveyor, drive, controls, anchorage devices, and appurtenances.
   3. Extent of the equipment is shown on the Drawings, and indicated in the schedule of service conditions in Part 2 of this Section.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before belt conveyor Work.
   2. Notify other contractors in advance of installing belt conveyor equipment to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before belt conveyor Work.

C. Related Sections:
   1. Section 01610, Transportation and Handling
   2. Section 01664, Training
   3. Section 03600, Grout
   2. Section 05051, Anchor Systems.
   3. Section 05120, Structural Steel
   4. Section 09900, Painting.
   5. Division 16, Electrical
   6. Section 17000, Instrumentation, Control and Monitoring System General Requirements.
   7. Section 17260, Process Control Panels and Hardware.
   8. Section 17275, Miscellaneous Panel Instruments.

1.2 REFERENCES

Standards referenced in this Section are:

A. AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.

B. ASTM A36/A36M, Specification for Carbon Structural Steel.

C. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

D. AWS D1.1/D1.1M, Structural Welding Code-Steel.

E. NEMA ICS 2, Industrial Control and Systems Controllers, Contactors and Overload Relays, Rated at 600 Volts.

F. NEMA ICS 6, Industrial Controls and Systems Enclosures.

G. NEMA 250, Enclosures for Electrical Equipment (1,000 volts maximum).

1.3 QUALITY ASSURANCE

A. Qualifications:
Manufacturer: Shall have a minimum of five years experience of producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
1. Obtain materials and equipment included in this Section, regardless of component manufacturer, from one belt conveyor equipment manufacturer.
2. Belt conveyor equipment manufacturer shall review and approve, or shall prepare, all Shop Drawings and other submittals for components furnished under this Section.
3. Equipment shall be specifically constructed for the specified service conditions. Equipment and components shall be integrated into overall belt conveyor equipment system by the belt conveyor equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following:
   a. Manufacturer's literature, illustrations, specifications, and engineering data including: materials, dimensions, weights, performance data, and part lists for all components in sufficient detail to allow an item by item comparison with the Contract Documents.
   b. Panel information:
      1) Layout Drawings, including the following:
         a) Front views to scale.
         b) Dimensional information.
         c) Functional name of components mounted in and on panel.
         d) Product information on all panel components.

e) Nameplate location and legend including text, letter size and colors to be used.
f) Location of anchoring connections and holes.
g) Location of external wiring connections.
h) Mounting, support and installation details.
i) Subpanel layouts and mounting details for items located inside panels.

2) Wiring diagrams, including the following:
a) Name of panel.
b) Wiring sizes and types.
c) Terminal strip numbers.
d) Color coding.
e) Functional name and manufacturer's designation for components to which wiring is connected.

3) Electrical control schematics in accordance with NFPA 79
4) Standards.
5) Detailed control description.

c. Drawings showing fabrication methods, assembly, accessories, installation details, and wiring diagrams.
d. List of deviations from the Contract Documents.
e. Listing of conveyor components and materials.
f. Provide a copy of the manufacturer's standard warranty for parts and labor.

2. Test Procedures: Submit and obtain ENGINEER's approval of test procedures for shop test and field operating tests prior to performing tests.

B. Informational Submittals: Submit the following:

1. Manufacturer's Instructions:
a. Special shipping, storage and protection, and handling instructions.
b. Installation data for the equipment, including setting drawings, templates, and directions and tolerances for installing anchorage devices.

2. Source Quality Control Submittals:
Report of results of testing and inspections performed at manufacturer's shop, including:
a. Operating tests and visual inspections.
b. Control panel shop test results.

3. Field Quality Control Submittals:
Report of results of field operating test.

4. Supplier Reports:
Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.

5. Qualifications Statements:
Manufacturer, when submittal of qualifications is required by ENGINEER.

C. Closeout Submittals: Submit the following:
Operations and Maintenance Data:
1. Submit in accordance with these Specifications.
2. Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts for Moderate Duty Belt Conveyor: Furnish the following
   a. Five belt pans with hardware.
   b. Ten guide blocks.
   c. Five chain attachments.
   d. Two scrapers.
2. Tools:
   Two sets of special tools, if any, required for normal operation and maintenance.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Packing:
   a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
   b. Protect machined surfaces and mating connections.
   c. Protect bearings and gearing with shop-applied corrosion-preventing coating.
   d. Cover all openings into gear boxes with-vapor inhibiting, water-repellent material.
2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work.
3. Comply with Section 01610, Transportation and Handling.

B. Storage and Protection:
Comply with all product storage and handling requirements of these Specifications.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
1. Provide equipment suitable for the process and service conditions in accordance with the service conditions specified in this Section, and in accordance with the Contract Documents.

2. Each belt conveyor shall include belt assemblies, belt guidance and tracking system, chain, track and track supports, drive station, tension station, drip pans, belt scraper(s), controls, and appurtenances.
3. Each conveyor shall consist of modular watertight conveying surfaces and shall be capable of making continuous vertical, turns and shall flatten out as conveyor travels over each drive station. Moving components, except drive and tension stations, shall pass a single designated point as shown for maintenance.
4. Equipment shall be suitable for continuous operation, 365 days per year, 24 hours per day, without damage to or failure of mechanism and drive components.

B. Service Conditions:
Equipment shall comply with the following:

Parameter	Service Condition Notes
Designation	CNV – 83CON3730
Location	Sludge Dewatering Building
Quantity of Belt Conveyors	1
Conveyed Material	Dewatered Sludge
Maximum Conveying Capacity (tons per hour)	2
Maximum Solids Content of Conveyed Material (%)	40%
Minimum Conveyor Belt Width (inches)	26
Approximate Belt Length* (feet)	47’ 0”
Inclination* (degrees)	28.4
Conveyor Drive Motor Size (horsepower)	2
Conveyor Drive Motor Electrical Power (volts, phase, frequency)	230/460 vac,3-phase, 60 Hertz
Maximum Conveyor Speed (feet per minute)	22
Conveyor Direction Capability	Forward - Only
* Data provided is approximate and subject to change with CONTRACTOR’s final layout. Field-verify required length and inclination and submit final layout with Shop Drawings. No extra compensation will be paid for minor revisions to belt conveyor length and inclination required. Extra compensation will not be paid for changes required for CONTRACTOR layout, substitutions, or alternatives awarded.	

2.2 MANUFACTURERS

Products and Manufacturers, Moderate Duty Belt Conveyors: Provide of one of the following:

A. P2 Pathwinder, by Serpentix Conveyor Corporation.
B. Keystone Conveyor

C. Or equal.

2.3 EQUIPMENT

A. General:
   1. Components of belt conveyor equipment shall be amply proportioned for continuous and uninterrupted service.
   2. Provide suitable provisions for lubrication, adjustment, and replacement of component parts requiring lubrication, adjustment, or renewal, as applicable.
   3. Projecting set screws and other projecting parts are not allowed. Unless specified otherwise, fasteners, nuts, and washers shall be Type 316 stainless steel. Nuts shall be mechanical locking type.
   4. Provide devices required for compliance with applicable safety Laws and Regulations.
   5. Belt conveyor equipment installed inside of building shall be supported from concrete floor within building. Belt conveyor equipment in exterior installations shall be supported from structural steel supporting structure as shown or indicated. Structural steel supports shall comply with Section 05120, Structural Steel and this Section. Supports to be within the manufacturer scope of supply and installed per manufacturer's requirements.
   6. Provide accessories including skirtboards at each point where material is located onto conveyor.
   7. Conveyor shall be suitable for conveying material at the incline indicated in the service conditions specified in this Section.

B. Moderate Duty Belt Conveyor:

   The conveying surface will consist of individually replaceable modular belt pan sections molded of moldable plastic rubber (MPR). The belt pans shall be fastened every eight (8) inches and supported by a nylon attachment and two (2) durable enhanced, plastic guide (and wear) blocks bolted to a case hardened alloy steel chain. The chain shall have a minimum breaking strength of 35,000 pounds. Each modular belt pan section will have a cleat-like convolution at least 1 1/2 inches high, permanently molded into the rubber. The closed-link alloy steel chain, with alternating horizontal and vertical links will allow for movement in two or more directions. The 4" pitch chain will be guided by the guide blocks bolted bilaterally to each vertical chain link. The belt pan attachments and guide blocks shall be shipped assembled on the chain. The chain and guide blocks will operate in a UHMWPE track consisting of a base, two sides and two top containment angles.

C. Conveyor System:
   1. Track and Track Supports:

a. Material:
   1) Belt conveyor structural members and supports shall be formed structural shapes and plates of ASTM A36/A36M steel complying with AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, except that minimum thickness specifications shall not apply to conveyor deck plates.
   2) Fasteners, nuts, and washers shall be steel, galvanized in accordance with ASTM A123. Nuts shall be mechanical locking type.
b. Provide hardened steel liners for load-bearing surfaces for inclined conveyors.
c. Shop welding shall be in accordance with AWS D1.1/D1.1M.
d. Structural steel shall be hot-dipped galvanized in accordance with ASTM A123 after fabrication.
e. Conveyor manufacturer shall design and provide structural support legs sufficient for equipment provided. Size support legs to properly support all loads associated with conveyor system, including live loads from the material conveyed.
f. Each support leg shall have base plate anchored to the floor at the Site.

2. Belt Assemblies:
   a. Belt assemblies shall be the width specified in the service conditions in this Section, comprised of pans of molded plastic rubber, supported and fastened to steel long-line chain at intervals of eight inches.
   b. Belt shall be in modular sections that facilitate replacing one section without replacing entire belt.
   c. Belt assemblies shall be watertight and shall have trough-shaped cross section
   d. Each belt pan section shall have convolutions at least 1.5 inches high.
3. Drive Station:
   a. Drive station shall consist of motor gear reducer chain and sprocket drive combination for conveyor capacity and belt speed specified.
   b. Provide single chain drive between reducer and sprocket shaft for protection in event of conveyor overload.
   c. Belt drive sheaves shall be interchangeable to provide different speed by using alternate-size sheaves.
   d. Directly-coupled drive motor-gear reducer combinations, without overload protection and speed change variability, are unacceptable.
   e. Provide readily removable sheet metal guards of rigid construction over exposed shafts, couplings, chain, and sprocket drives and other moving parts. Guards, including reinforcing strips, angles, wire mesh, hinges, rivets and other members, shall be of galvanized steel.
   f. Motors:
      1) Motors shall be TEFC, severe duty, suitable for outdoor operation.
      2) Motors shall comply with Division 16 of these Specifications.
      3) Motors shall be of adequate size so that there is no overload on motor above rated nameplate horsepower under specified service conditions,

but not less than horsepower indicated in service conditions specified in this Section.

4) Provide space heaters, 120-volt, single-phase, 60 Hertz.
5) Motors shall have 1.15 service factor.
6) Motor thrust bearings shall be adequate to carry continuous thrust loads under all conditions of service, and shall have minimum B-10 life of 100,000 hours.
7) Motor terminal boxes shall be oversized to provide adequate space for connections. Terminal boxes shall be cast-iron or fabricated steel, with bolted, neoprene-gasketed cover. Permanently mark motor leads in accordance with connection diagram.

4. Tension Station:
   Tension station shall consist of tail sprocket, constant pressure, spring-loaded chain tensioner adjustable by single ratchet, mounted in a structural frame ready for installation at the Site.
5. Drip Pans:
   a. Provide drip pan beneath conveyor for conveyor's full length.
   b. Drip pan shall pitch at minimum slope of 1/4-inch per foot to cleanout hopper.
   c. Drip pans shall be 16-gage Type 316 stainless steel.
   d. Turn up edges of drip pans by minimum of 2.5 inches. Drip pans shall extend beyond each side of conveyor belt to the conveyor frame. Overlap adjoining drip pans to prevent leakage between drip pan sections.
   e. Drip pan shall terminate within the press containment area.

6. Belt Scrapers:
   a. Provide pre-tensioned scraping mechanism with replaceable rubber blade and ultra-high molecular weight polyethylene backing plate to continuously remove material from the conveying surface. Provide scraper at conveyor discharge.
   b. Scraper shall be manufactured by belt conveyor system manufacturer.
   c. Arrange scrapers to direct scraped material into a discharge hopper (roll-off container).
7. Belt Conveyor Accessories:
   Discharge Skirtboard:
   a. Provide fixed skirt plates at location where process equipment discharges material to the belt conveyor, to induce conveyed material onto the conveyor.
   b. Skirtboards shall be 3/8-inch thick high-density polyethylene, approximately 11 inches high on a 30-degree angle from vertical, supported from the conveyor frame by brackets. Brackets shall be Type 316 stainless steel.

c. Provide Discharge Chute at discharge of conveyor for transfer of sludge into roll-off container (See Drawings) fabricated from Type 316 stainless steel..

2.4 CONTROLS

A. General:
1. Provide remote and local manual control of belt conveyor system as shown and indicated.
2. Control panels shall comply with Section 17260, Process Control Panels and Hardware and Section 17275, Miscellaneous Panel Instruments, and to NEMA 250, NEMA ICS 2, and NEMA ICS 6.
3. Provide control functions as shown or indicated in P&IDs.
4. Provide control panels with power disconnects.
5. Install control panels as shown. If mounting is not shown, provide corrosion resistant supports by Unistrut or equal, for panel installation.
6. Interlocks: Provide control interlocks as shown and specified. Test interlocks for proper function.

B. Belt Conveyor Local Control Panel:
1. Provide Local Control Panel (LCP) for each belt conveyor provided.
2. Panel shall be stainless steel 316L NEMA 4X.
3. Provide the following in each LCP:
   a. Motion sensor protection controller module or provide power for the sensor if it is installed on the conveyor.
   b. Pull cord emergency-stop (E-stop) interlock circuitry.
   c. Motor starter with main circuit breaker and solid state overload relays.
   d. Horn and strobe for audible/visual alarm. Provide horn silence and reset circuitry.
4. LCP shall be provided with the following: LOCAL/REMOTE (L/R) selector switch, RESET, ESTOP, START and STOP pushbuttons; “Fault”, “Overload”, “Pull cord”, “Misalignment”, “Run”, and “Off” indicating lights.
   a. Local/Remote:
      1) L/R switch in LOCAL shall indicate a “Not in Remote” alarm. Selection of local or remote control shall not interrupt the current operating status of the conveyor (i.e. shall not start or stop the conveyor).
      2) In LOCAL, conveyor shall be controlled manually via the local pushbuttons.
      3) In REMOTE, conveyor shall be controlled automatically by the Belt Filter Press Control Panel.
   b. Indicating light for “ZERO SPEED” will illuminate when run contact is closed and motion failure alarm is activated.
   c. Activation of horn and strobe will be triggered on the following events:

1) Stop switch emergency cord is pulled. Alarm will remain active until silence or reset pushbutton is pressed.
2) Prior to associated conveyor start. The alarm will activate at least 15 seconds (adjustable) prior to associated conveyor start as a warning alarm. Alarm will remain on for 5 seconds (adjustable) after associated conveyor start, and then automatically stop.

5. Minimum Hardwired Input Output points requirement for remote control and monitoring
   a. Belt Filter Press No. 1 Control panel.
      1) Belt conveyor Start/Stop.
      2) Belt conveyor Running Status.
      3) Belt conveyor In remote.
   b. Belt Filter Press No. 2 Control panel.
      1) Belt conveyor Start/Stop.
      2) Belt conveyor Running Status.
      3) Belt conveyor In remote.
   c. Foxboro DCS, CP-DB Control Panel.
      1) Belt conveyor Running Status.
      2) Belt conveyor In remote.
      3) Belt conveyor Misalignment Alarm.
      4) Belt conveyor Zero Speed Alarm.
      5) Belt conveyor E-Stop.
      6) Belt conveyor Overload.
      7) Belt conveyor Pull-cord.

C. Motion Failure Alarm:
   1. Provide each belt conveyor with motion failure alarm system consisting of non-contacting heavy-duty motion sensor installed to detect motion of tail pulley shaft, and LCP-mounted and powered motion sensor alarm circuitry.
   2. Motion sensors shall include phenolic body and internal pre-amp.
   3. Provide stainless steel motion sensor mounting bracket.
   4. Motion sensor controller shall have built-in zero to sixty-second time delay, to allow monitored equipment to reach normal operating speed after conveyor start command.
   5. Product and Manufacturer:
      a. Elecro Sensor, SCP 1000, with PVC magnetic wrap.
      b. Milltronics MFA-4P controller with MSP 12 motion sensor
      c. Or equal.

D. Emergency Stop System:
   1. Provide each belt conveyor with an emergency pull cord and safety stop switch system, with indicating flags. Provide manual reset type pull switches mounted near the motor. Provide cord around each side of belt conveyor, and shall be accessible from each area of conveyor where routine maintenance will

be performed. Pulling cord shall activate emergency stop circuit causing belt conveyor to immediately stop.

2. Install emergency stop switches in accordance with manufacturer's instructions.
3. Products and Manufacturers: Provide products of one of the following:
   a. Material Control Inc. – Model PCL-2SX & PCR-2SX
   b. Scientific Technologies, Inc., Model ER4020.
   c Conveyor Components Company, Model RS.
   d. Or equal

E. Mis-alignment Switch:
   1. Provide each belt conveyor with a pair of actuating arm style mis-alignment switches mounted at both ends of each belt conveyor.
   2. Mis-alignment switch shall be suitable for explosion proof duty.
   3. Switch housing shall be cast iron.
   4. Actuating arm shall be epoxy coated steel roller with stainless steel shaft.
   5. Products and Manufacturers: Provide products of one of the following:
      a. Conveyor Components Company, Model TA.
      b. Or equal

F. Magnetic Starters:
   1. Type: Magnetic coil operated, horsepower rated, NEMA sized with thermal overload protection.
   2. Enclosed combination starter with magnetic only motor circuit protector and external operable, pad lockable handle.
   3. Functional Type: Full voltage, single speed, non-reversing unless otherwise noted on Drawings.
   4. Control power transformer fused and grounded on low voltage (120 V) side for each starter.
   5. Overload Relays: Three bimetallic type, manually reset from outside the enclosure by means of an insulated button with normally open auxiliary contact for remote alarm purposes and separate heater elements sized for the full load amperes and service factor of the actual motors furnished.
   6. Auxiliary contacts for motor space heaters, remote status signals and interlocks as shown on Drawings.
   7. Start and stop control stations, selector switches, pilot lights and other devices as shown on Drawings.
   8. Enclosures: NEMA rating shall be as required for area classifications.
   9. Product and Manufacturer: Provide one of the following:
      1) Type A 206 by Cutler-Hammer (Eaton).
      2) Type CR287 by General Electric Company.
      3) Bulletin 513 by Allen Bradley Company.
      4) Or equal.

G. Transformer:

Provide voltage transformer to step down incoming 3-phase power at each site to 120VAC control voltage.

2.5 ANCHORAGE DEVICES

Provide anchorage devices and nuts of ample size and strength for the purpose intended, sized by equipment manufacturer. Anchorage device materials shall be in accordance with Section 05051, Anchor Systems.

2.6 FINISHING

A. Equipment including motors, frames, and appurtenances, that does not otherwise receive a galvanized finish, shall receive shop-applied finishing in accordance with Section 09900, Painting, including surface preparation. Do not paint stainless steel, plastic, and machined components.

B. Gears, chains, bearing surfaces, machined surfaces and other surfaces that are to remain unpainted shall receive a heavy application of grease or other corrosion-inhibiting coating. Maintain coating during storage and until equipment is placed into operation.

2.7 LUBRICANTS

Provide and lubricants required for initial operation. Lubricants shall be as recommended by equipment manufacturer.

2.8 SOURCE QUALITY CONTROL

Tests: Perform the following tests and inspections at the factory:

A. Operating Test: Operate drive station and job motor at normal operating speed for two hours using a rust inhibiting break-in oil prior to shipment to check for proper operation, excessive noise and vibration.

B. Visual Inspection: Verify that equipment complies with these Specifications and approved Shop Drawings.

C. Control Panel Factory Test: Perform factory testing of all control panel functions.

PART 3 – EXECUTION

3.1 INSPECTION

Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install materials and equipment in conformance with Laws and Regulations, applicable standards, manufacturer's instructions and recommendations, and the Contract Documents.

B. Anchorages and Base Plates:
   1. Provide anchorages in new or existing concrete, as applicable, in accordance with equipment manufacturer's recommendations and the Contract Documents.
   2. Where used, pour concrete bases up to one inch below equipment baseplate or support leg as applicable. Base with equipment mounted thereon shall then be accurately shimmed to grade and spaces between filled with non-shrink grout in accordance with Section 03600, Grout. After grout has reached its initial set, exposed edges shall be neatly cut back 1/2-inch.
   3. When mounting to ceiling or suspended beams, the connection requirement must be bolted and the hardware welded. Ceiling trusses/members must be adequate to support the conveyor weight as shown on the general arrangement/shop drawings. If wood trusses are used, the connections must have steel members saddled over several trusses and then bolted and the hardware welded to secure mounting.

C. General:
   1. Where supports cross expansion joints, chamfer rails and cut rail ends at 45-degree horizontal angle to provide smooth travel over the joint.
   2. Perform all drilling and fitting required for installation. Set equipment accurately in location, alignment, and elevation, plumb, true, and free of rack.
   3. Making plate cutouts or openings in the field is not allowed.
   4. Fit exposed connections accurately together to form tight hairline joints.
   5. Secure plates to supporting members or frames with zinc or cadmium coated machine screws for steel, and stainless steel screws for aluminum and stainless steel.
   6. For contact surfaces between aluminum and dissimilar surfaces, use a coat of bituminous paint or other approved insulating material.
   7. Align and adjust equipment including motors, belts, and drives, in presence of ENGINEER.
   8. Align and adjust equipment, including motors, belts, chutes, hoppers, and other components of the system, in accordance with equipment manufacturer's instructions.
   9. Provide motion sensor for each equipment item, including appropriate mounting brackets, coordinating location of sensors, and installing sensors.
   10. Prior to energizing electric motor-driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

1. After installation, CONTRACTOR and qualified field service representative of manufacturer shall conduct at the Site operating tests of equipment, including all functions, and controls, in presence of ENGINEER. During tests, verify that equipment and appurtenances are compatible with tank and other, related facilities.
2. Field Operating Test, General:
    a. Field test equipment and associated controls in local mode as applicable, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part individually and all parts together function properly in manner intended. Equipment shall operate in a smooth, even manner, without vibrating, jerking, spasmodic motion (crabbing), jamming, and overheating to satisfaction of ENGINEER. Total duration of testing shall be 4 hours minimum, continuous and uninterrupted, in automatic mode. All testing equipment and labor shall be by CONTRACTOR.
    b. Should tests indicate defective Work, including malfunctions, make necessary repairs, revisions, and adjustments and restart test from the beginning. Repeat tests and repairs, revisions, and adjustments until, in ENGINEER's opinion, installation is complete and equipment is functioning properly and accurately, and is ready for permanent operation.

B. Manufacturer's Services: Provide a qualified, factory-trained serviceman to perform the following:
1. Supervise unloading and installation of equipment.
2. Instruct CONTRACTOR in installing equipment.
3. Inspect and adjust equipment after installation and ensure proper operation.
4. Instruct operations and maintenance personnel in operation and maintenance of the equipment.
5. Manufacturer's technician shall make visits to the Site as follows:
    a. First visit shall be for supervising unloading and handling of equipment and for instructing CONTRACTOR in proper equipment installation, and assisting in installing equipment. Minimum number of hours on-Site: 4 hours.
    b. Second visit shall be for checking completed installation, start-up of system; and performing field quality control testing. Minimum number of hours on-Site: 4 hours.
    c. Third visit shall be to instruct operations and maintenance personnel.
        1) Furnish services of manufacturer's qualified, factory-trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment.
        2) Training requirements, duration of instruction, and qualifications shall be in accordance with Section 01664, Training.
    d. Technician shall revisit the Site as often as necessary until installation is acceptable.
6. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

END OF SECTION

DIVISION 15

MECHANICAL

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SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 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 work shown on the Drawings..

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, other Contractors, 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.

1.2 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: (Verify with City of Atlanta Code Department for latest updates):
   a. International Building Code, 2012 Ed. with Georgia Amendments.
   b. International Mechanical Code, 2012 Ed. with Georgia Amendments.
   c. International Energy Code, 2009 Ed. with Georgia Supplements and Amendments.
   d. International Plumbing Code, 2012 Ed. with Georgia Amendments.
   e. International Fuel Gas Code, 2012 Ed. with Georgia Amendments.
   f. International Fire Code, 2012 Ed. with Georgia Amendments
   g. 2012 NFPA 101. Life Safety Code with State Amendments.
   h. National Electrical Code, 2017 Ed. with no Georgia Amendments
   i. 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.

1.3 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.

1.4 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.

1.5 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.

1.6 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.

1.7 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

2.1 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. All products and materials shall be suitable for the intended service.
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

Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.

a. Copper, Steel, and Stainless 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. Consult relevant Sections in Division 11 for additional Equipment Base specifications.

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 conform to the requirements of Section 05051, Anchor Systems.
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

3.1 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 when required. Existing titanium and ductile iron wall pipes shall be left in place and reused whenever possible. See Section 15060 for pipe sleeve material requirements. 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.
   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 1.6 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, process chemicals, 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 chemical systems. In the main water and chemical 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.

3.2 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 Section 09900, Painting.

B. Touch up 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 Section 09900, Painting. The painting shall not impair the performance of the equipment in any manner.

3.3 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 1 1/2 times the rated system pressure or 100 psig, 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.

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.

3.4 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

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SECTION 15056

PIPE SUPPORTS

PART 1 - GENERAL

1.1 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 supports for pipe ½ in. and larger, provide shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

E. 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 2.3 F.

F. Design and provide all temporary pipe supports required during installation and testing.

1.2 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

1.3 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):

D. ASME/ANSI B31.1: Power Piping Code.

E. American Welding Society (AWS) Code:

F. Structural Welding Code D1.1.

G. 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

H. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

I. OSHA

1.4 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 a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

1.5 SUBMITTALS

Shop Drawings: Submit the following in accordance with the General Conditions:

A. Pipe support drawings specified in paragraph 1.1 B 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.
   1. Detailed drawing of the device with dimensions.
   2. A table of applied forces and moments.
   3. A complete bill of materials.
   4. A unique identification and revision level.
   5. 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 1.6 D.
   6. Detailed connections to existing structure.
   7. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1-1.7.

B. Welding Procedure: Submit description as required to illustrate each welding procedure to be performed in the specified work.

C. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.

D. 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.

E. Pipe support manufacturers' qualifications as specified in paragraph 1.6 D.
   1. 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.
   2. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, whom stamps and seals shop drawings and designs.

F. Coordination drawings for pipe supports shall include as a minimum the following information.
   1. Coordination drawings shall include all pipe supports covered by Section 15060.
   2. 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.
   3. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
   4. 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.
   5. 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.
   6. 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.
   7. 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.

8. 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.

G. Written notification of any deviations from the requirements of this specification.

H. Support documentation and justification as specified.

I. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.

1.6 QUALITY ASSURANCE

A. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures 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 for Class D concrete 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 5 years experience in the design and fabrication of pipe supports.
3. Have completed the design and fabrication of at least 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 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 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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Shipping:
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.

1.8 SPECIAL REQUIREMENTS

Refer to applicable specification sections of Division 1 and provide the following.

A. Foundations, installations and grouting.

B. Bolts, anchor bolts, and nuts.

C. Sleeves and inserts.

D. Protection against electrolysis.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carpenter & Paterson.

B. Grinnell Corporation.

C. Basic Engineers Inc.

D. Or equal.

2.2 MATERIALS:

A. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

B. Provide Type 316L stainless steel for all exterior or interior pipe supports, hangers, guides, restraints, and anchors that are not otherwise specified.

C. Supports, hangers, guides, and restraints in contact with corrosive chemicals or in chemical containment areas shall be pultruded FRP of premium grade vinyl ester resin. FRP fabrications shall comply with recommended practices of the American Composites Manufacturers

Association. Fire resistance of FRP fabrications shall meet or exceed the requirements for Class 1 flame rating of 25 or less when tested in accordance with ASTM E84 and self-extinguishing requirements of ASTM of ASTM D635. Color of products shall be yellow.

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, plates A-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: Conslide 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 .

1. 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:
2. Tensile strength - 2,000. psi
3. Elongation - 225%
4. Specific Gravity - 2.17 to 2.22
5. The coefficient of friction shall average 0.06 under compressive load of 2,000 psi.
6. The compressive creep shall be a minimum of 2% at 2,000 psi and 70 degrees F.
7. 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.

G. Stainless Steel concrete anchor bolts per Section 05051, Anchor Systems.

H. Provide Titanium anchor bolts for supports in contact with corrosive chemicals including chemical containment areas.

2.3 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS

A. Design and provide pipe supports for piping ½ in. and larger to include the following loads:

1. 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.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.
3. 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 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 2.2 B.

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.

2.4 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.

2.5 SHOP PAINTING

A. Primer and Finish Paint: Shop apply to all ferrous surfaces. Refer to Section 09900 for coating requirements.
   1. Color: As specified for piping system of same service or as selected by the Engineer.

2. Provide similar additional paint for touch-up after installation.

B. Surface preparation, mixing and application and safety requirements shall be in accordance with the paint manufacturer's printed instructions.

C. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

PART 3 - EXECUTION

3.1 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. 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.

3.2 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.

3.3 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.

3.4 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 stainless 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. All rigid rod hangers shall provide a means of vertical adjustment after erection.

M. 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.

N. 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.

O. 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.

P. 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.

Q. 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.

R. All threads shall be UNC unless otherwise specified.

S. TFE slide bearing plates with stainless steel backup plates shall be stitch weld attachments to the structure. A 1/8 in. fillet weld, ½ in. long every 3 inches on center 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.

3.5 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

SECTION 15060

PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 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, Earthwork.
   2. Section 09900, Painting.
   3. Section 15063, High Density Polyethylene Process Pipe

1.2 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.

1.3 QUALITY ASSURANCE

Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. American National Standards Institute (ANSI).

B. American Society for Testing Materials (ASTM).

C. American Welding Society (AWS).

1.4 QUALITY STANDARDS

A. All such work shall be done by competent workmen in a thorough workmanlike 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.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage
   1. All piping and tubing and accessories shall be stored 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.
   2. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
   3. Pipe and fittings other than HDPE and PVC may be stored outdoors without cover. Cover HDPE and PVC pipe and fittings stored outdoors.

C. Handling:

1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free from dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

1.6 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: 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 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 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-inches and larger shall be of the butt welded type of pickled and passivated stainless steel matching the piping and conforming to ASTM A 774, 316L and ANSI B16.9. All elbows 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 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 3-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 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 EPDM or neoprene 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
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.
   a. For socket weld, use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564. Application shall be in accordance with manufacturer's recommendations.
   b. Flanges, where shown, shall be 150-pound, and shall be of the same material as the pipe. Provide with backup flanges minimum 1/8-inch thick. Backup flanges shall be Type 316 stainless steel.
5. Bolts for use with PVC flanges shall be 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 and compatible with the process fluid, full-faced, and 1/8-inch thick, minimum. For all NaOCl applications, gaskets shall be Viton.
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 inches 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 pipe lines shall conform to the requirements of ANSI/AWWA C110/A21.10-82, Pressure Class 350 for 12 inch and smaller and Pressure Class 250 for 14 inch and larger sizes.
3. Grooved end fittings shall be ductile iron and conform to the requirements or ANSI A21.10/AWWA C110 for center-to-end dimensions, and ANSI A21.10/AWWA C110 or AWWA C153 for wall thickness. Grooved ends shall conform to AWWA C606.
4. Exposed joints shall be as indicated on the Drawings. Buried joints shall be push-on or mechanical joints and shall conform to the following requirements:

Joint Types	Standard Requirements
Flanged	ANSI/AWWA C110 & ANSI B16.1, faced and drilled 125-pound 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
Grooved End	ANSI/AWWA C606

5. Restraining of joints shall be as recommended in AWWA M41 – Ductile Iron Pipe and Fittings.
6. Mechanical joints with retainer glands are not acceptable.
7. Flanges shall be ductile iron, threaded, rated for 250 psi working pressure, and conform to ANSI A21.15/AWWA C115 and ANSI 125 pound drilling.
8. 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.
9. 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 inch 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 pound FF flanges.

E. 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 conforming 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.

F. 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.

G. Couplings

1. Flexible couplings, flanged coupling adapters, or expansion joints shall be provided for piping systems where shown on the Drawings. 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 Type 316 stainless steel 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 inches 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 inches and larger shall consist of a high strength steel, flanged body drilled to mate with a 125 pound 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.
    d. Grooved Joint Couplings:
        Victaulic Style 31, with Grade S, Flushseal, nitrile gasket for abrasive sludge/grit application, or equal.
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 1102 (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.

H. Piping Insulation

1. Indoor Piping Systems:

a. Insulate indoor piping, as shown in the Pipe Insulation Schedule below and specified below, with rigid fiberglass insulation wrapped with factory-applied, vinyl coated vapor barrier jacket with pressure-sensitive, self-sealing lap, UL rated. Circumferential joints shall be sealed with matching pressure-sensitive butt strips. Insulation shall be Owens-Corning Fiberglass ASJ/SSL-11, Manville Micro-Lok 650 with AP-T jacket or equal.

b. Buried piping shall not be insulated.

c. Insulate indoor fittings with premolded insulation or mitered segments, wired in place, and finished with a thin coat of insulating cement, or wrapped with soft fiberglass insulation inserts covered with premolded PVC fitting covers. Secure cover and wrap throat and seams with matching PVC tape. Fitting covers shall be Zeston, Speedline, or equal.

d. Insulation at each pipe hanger or support shall include inserts installed between piping and hanger or support. Inserts shall consist of preformed rigid pipe insulation of thickness equal to adjoining insulation. Inserts shall be 10 inches in length and shall include vapor barrier.

2. Outdoor Piping Systems:

a. Heat trace outdoor exposed piping and fittings to the extent shown on the Drawings. Heat trace tape shall be constant wattage, self-regulating type rated at 8 watts per foot. Heat tracing and insulation shall maintain piping at a minimum temperature of 40 °F at an ambient temperature of 0 °F. Heat tape shall be powered by 120V ac single-phase circuits. Heat tape shall be CWM as manufactured by Chromalox, or equal

b. Insulate outdoor piping, valves and fittings as specified in the Pipe Insulation Schedule below. Use the same materials as specified for indoors. Cover outdoor piping and insulation with 0.016-inch thick aluminum jacket. The jacket shall be held in place by a continuous friction type joint, providing a positive weatherproof seal over entire length of jacket. The

circumferential joints shall be secured with preformed snap straps containing weatherproof sealant. Cover outdoor fittings with matching preformed aluminum jackets, two-piece elbows and flange covers, secured with stainless steel bands. Fitting covers shall be as manufactured by Childers, Papco, or equal.

Pipe Insulation Schedule

	Insulation Thickness (inches)			
	Indoor		Outdoor Exposed	
Service	1" and smaller	1.25" and larger	4" and smaller	4-½" and larger
Cold Water (CW)	1	1.5	N/A	N/A
Hot Water (HW)	1	1.5	N/A	N/A
Potable Water (W1 and W2)	1	1.5	1.5” thick w/ weatherproof jacket	2” thick w/ weatherproof jacket
Non-Potable Plant Water (W3)	1	1.5	1.5” thick w/ weatherproof jacket	2” thick w/ weatherproof jacket
Sludge (SL)	N/A	N/A	1.5” thick w/ weatherproof jacket	2” thick w/ weatherproof jacket

I. Pipe Hangers and Supports:

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.

J. Building Piping:

a. Horizontal piping shall be supported with adjustable Clevis type hangers as shown. Furnish stainless steel 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 horizontal runs of piping along walls shall be supported by a stainless steel hanger bracket framing system attached with Type 316 stainless steel anchors or concrete inserts as applicable, Unistrut, Kin Line, or equal. No pipe shall be supported from the pipe above or below it.

c. Stacked horizontal runs of piping along ceilings shall be supported by a stainless steel trapeze type framing system attached with Type 316 stainless steel anchors or concrete inserts as applicable, Unistrut, Kin Line, or equal. No pipe shall be supported from the pipe above or below it.

d. 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.

e. Horizontal piping runs along floor shall be supported by stainless steel or glass fiber reinforced plastic channel and shall have lateral movement restricted. Framing shall be Cooper Industries, Unistrut, or equal. Floor supports in chemical containment areas shall be glass fiber reinforced plastic.

f. Supports for chemical piping shall be glass fiber-reinforced plastic with a flame spread rating of 25, in accordance with ASTM E 84. All fasteners shall be manufactured from long glass fiber-reinforced polyurethane to ensure strength and corrosion resistance. All-thread rods shall be made from vinylester resin. Products shall be Aickinstrut, Unistrut, or equal.

g. 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 inches thick with lag screws and angle clips.

h. Piping supports for vertical piping passing through floor sleeves shall be stainless steel riser clamps, Grinnell Figure 261; or equal.

i. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories for non-chemical service shall be stainless steel.

j. Fixed supports shall be fitted with rigid top strap or clamp of the same material as the support. If metal straps or clamps are used on plastic piping, they shall be coated with a plastic or neoprene protective cover.

k. Horizontal pipe support or hanger spacing and hanger rod sizing shall be as shown on the Drawings.

l. The load rating for universal concrete inserts shall not be less than that of the hanger rods they support.

m. When supporting ductile iron pipe, locate hanger rods at all nonrigid joints and at each change of direction.

n. Vertical sway bracing shall be provided where shown, or on 10 foot maximum centers.

o. 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.

K. Slab, Floor, Wall, and Roof Penetrations and Closures

1. Unless otherwise indicated on the Drawings, openings for the passage of pipes through floors, walls, and roofs shall be formed of sleeves of standard-weight, stainless-steel pipe. The sleeves shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be of sufficient length to be flush at the walls and the bottom of slabs and to project 4-in. above the finished floor surface. Threaded nipples shall not be used as sleeves.

2. All sleeves shall be set accurately before the concrete is placed or shall be built in accurately as the masonry is being built. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls.

3. 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 Type 316 stainless steel bolts and nuts and stainless 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.

4. Pipe sleeves within chemical containment areas shall be PVC. Annular space between sleeve and carrier pipe shall be sealed with Link-Seal modular seals constructed of materials compatible with the contained fluid.

L. Flexibility:

1. Unless otherwise specified, piping 2 inches 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 feet of the face of the structure. The second joint shall be located 2 feet 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 for plant water service shall be rubber type designed for temperatures up to 180 F and pressures up to 150 psig. Construct expansion joints of neoprene or Buna-N. Expansion joints shall be filled arch type. Provide backup or retaining rings as recommended by expansion joint manufacturer. Expansion joints shall be yoked in manner to provide transmission of tension loading to which expansion joint may be subjected during system operation. Compression or lateral movement of expansion joint shall not be impaired by yoking system. Details of expansion joint yoking shall be submitted to ENGINEER for approval. Expansion joints shall be as manufactured by Mercer Rubber Company, US Rubber Supply Company, or Equal.
3. Expansion joints/flexible couplings for Sodium Hypochlorite and Sodium Bisulfite service shall be multi-ply bellows type designed for temperatures up to 200 F and pressures up to 60 psig. Expansion joints shall allow a minimum of 1 inch of axial movement and ½ inch of misalignment. Bellows shall be constructed of PTFE (Teflon). Unless otherwise specified, end connections shall be flanged. Flanges and hardware shall be of Type 316 stainless steel construction. Expansion joints shall be as manufactured by Mercer Rubber, Flexicraft Industries, or Equal.

N. Pipe Identification

The following shall be continuously printed on the pipe or spaced at intervals not exceeding 10 feet.

1. Name and/or trademark of the pipe manufacturer.
2. Nominal pipe size.
3. Schedule number.
4. Manufacturing standard reference, e.g., ASTM F441.
5. Production code from which the date and place of manufacture can be determined.
6. Provide pipe identification labels and directional arrows on all above grade piping.

O. Protective Coating for Piping

1. Interior. Ductile iron process pipe for sludge, thickened sludge, drain line, and main holding tank drain service shall receive a factory applied ceramic epoxy lined coating of Protecto 401 as manufactured by Induron Coatings Inc., Birmingham, AL, or equal, and applied at a nominal thickness of 40 mils. Ductile iron pipe for plant water shall have standard cement mortar lining.
2. Exterior. Field coat exposed piping in conformance with Section 09900, Painting.

PART 3 - EXECUTION

3.1 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 this section. All pipe 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. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)
9. 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.
10. 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.
11. 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.
12. 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.
13. 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.
14. Vent and drain valves shall be inserted in all high and low points of all pipes. Sizes of vent and drain valves shall be as approved by Engineer, but at a minimum shall be 1-inch size.
15. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.
16. Minimum pipe cover shall be 3 feet, as measured from the pipe barrel, unless otherwise indicated on the Drawings.

B. Installation of Stainless Steel Pipe, tubing and fittings:

1. Welding electrodes for shielded metal arc process on Type 316L stainless steel pipe and the Gas Tungsten Arc or Gas Metal Arc process shall be per current AWS standards for each. 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 ASME approved 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 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 degrees F. If the ambient is less than 32 degrees 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.

C. Installation of PVC Pipe and Fittings:
    1. All PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer’s recommendations. Buried 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 solvent welded or flanged connections where possible to connect to valves or fittings. Use Schedule 80 threaded nipple for connections to threaded valves. Avoid threaded connections when possible. 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 degrees F, nor above 90 degrees F when exposed to direct sunlight. Ends to be joined shall be shielded from direct sunlight prior to and during the laying operation.

D. 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.
5. Grooved Joints: Install in accordance with the manufacturer’s latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended

service. A factory trained representative (direct employee) of the coupling manufacturer shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. The representative shall periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed. Contractor shall remove and replace any improperly installed products.

E. Installation of Copper Pipe

1. For copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
2. Soldered Joints:
   a. Assemble copper tubing with soldered joints. Solder shall be 95-5 tin-antimony solder conforming to ASTM B32.
   b. Ream or file pipe to remove burrs.
   c. Clean and polish contact surfaces of joints.
   d. Apply flux to both male and female ends.
   e. Insert end of tube into full depth of fitting socket.
   f. Heat joint evenly.
   g. Form continuous solder bead around entire circumference of joint starting at the bottom.
3. Threaded Joints:
   a. When open flames for soldering are impractical, or at unions and connections to equipment and appurtenances, assemble copper tubing with flared ends as permitted by authority having jurisdiction.
   b. Ends of tubing shall be flared at an angle of 45 degrees with flaring tool recommended by pipe manufacturer. Flaring tool shall have same outside diameter as tube to be flared.
   c. Tubing to be flared shall be soft temper or annealed prior to flaring.
   d. End of tube shall be cut square and reamed to remove burrs.
   e. Tube that is out-of-round shall be resized back to round.
   f. Clean and polish contact surfaces of joints using an abrasive cloth.
   g. Place flare nut over the end of tube with threads closest to end being flared.
   h. Insert appropriate length of tube between flaring bar of flaring tool and position the yolk with flaring cone over tube end and clamp yoke in place.
   i. Turn handle of yolk clockwise without over-tightening. Cracked or deformed tubes will be rejected.
   j. Do not apply jointing compounds to mating surfaces of flare fitting and flared tube end before attaching flare nut to threaded connection.

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 45-degree 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 45-degree 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 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 shall be as specified hereinbefore.
3. The Contractor shall provide restrained joints for all buried piping, except RCP, with test pressure higher than 20 psig.

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. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300, Cast-in-Place 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
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.

L. Insulating Flanges, Couplings, and Unions
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.

M. Insulation
1. All piping and equipment shall be insulated as shown on the Drawings and in accordance with manufacturer's instructions including types of insulating cements, lagging adhesives, and weatherproof mastics if different from those specified. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc.
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 as shown on the Drawings and as specified. 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 manufacturer’s recommendations and make electrical connections.

3.2 SURFACE PREPARATION AND SHOP PAINTING

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.

3.3 FIELD PAINTING

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.

3.4 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 feet 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-inch-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 inches and over. Characters shall be 2 inches 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 inches 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.

3.5 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.

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.

D. Buried Water and Wastewater Pressure Lines:

1. The hydrostatic testing of these pipelines must be conducted as follows:

   a. 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.

b. 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

c. The Contractor shall correct any leakage greater than the allowance determined under this formula at the Contractor's sole expense.

d. For HDPE testing, see Section 15063.

2. Initial Service Leak Tests:

a. Equipment: Equipment used for initial service leak testing may be the same as that specified under Paragraph Hydrostatic 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. 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.

3. 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
4. Remarks, to include such items as:
   a. Leaks (type, location)
   b. Repairs made on leaks

3.6 INTERIM CLEANING

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.

3.7 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 feet per second. 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 inch 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.

C. Corrosion Protection of Piping Systems

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.

D. Pipe support systems shall be painted No. 70, light gray, as specified in ANSI Z55.1; Tnemec Co., Inc. No. 2050; or equal.

E. Corrosion protection for buried piping systems, other than copper piping, is not required.

3.8 CORROSION PROTECTION FOR COPPER PIPING

A. For Atmospheric Exposed Copper Pipe: Copper piping shall be painted in accordance with Section 09900, Painting.

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 primer 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 above grade to permit joint wrapping without contamination. Pipe wrap tape and pipe wrap primer shall be as manufactured by PASCO Specialty & Mfg., Inc. or equal.

3.9 DISINFECTION

A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-14, 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 percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite[(1)] (65-70 percent Cl)	1 lb	7.5 gal.
Sodium Hypochlorite[(2)] (5.25 percent 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 nonspore 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 receiving waters from harmful or toxic concentrations of chlorine. 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.

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.

PIPE SCHEDULE							
SERVICE	FLOW STREAM ID	SIZE (IN)	MATERIAL		PIPE TESTING		
			Exposed	Buried	Type***	Test Pressure (psig)	Test Duration (hours)
Chemical drain	CMD	12 and smaller	PVC	PVC	H	20	2
Cold water	CW	3 and under	Copper type L	Copper type K	H	150	2
Drain (*Includes ARV discharges)	D	4 and under	PVC/Stainless Steel	PVC	H H	20 20	2 2
		6 and greater	Ductile iron (CEL*)	Ductile iron (CEL*)	H H	20 20	2 2
Hot water	HW	3 and under	Copper type L	Copper type K	H	150	2
Sodium hypochlorite	NaOCL	All	PVC	PVC	H	150	2
Overflow	OF	3 and smaller	PVC	PVC	H	20	2
		4 thru 12	Ductile iron (cement lined)	Ductile iron (cement lined)	H	20	2
Polymer	POL	All	PVC	PVC	H	150	2
Sludge	SL	Inside sedimentation basins (4 and smaller)	Type 316 stainless steel	NA	H	100	2
Sludge	SL	Outside sedimentation basins (4 and greater)	Ductile iron (CEL*)	HDPE	H	100	2
Sample	SMP	All	Stainless Steel	NA	H	50	2
Thickened Sludge	TS	All	Ductile iron (CEL*)	HDPE	H	100	2
Fluidizing water (for sludge pumps)	FL	3 inch and smaller	Type 316 stainless steel	NA	H	150	2
Fluidizing water (for sludge pumps)	FL	4 inch and larger	Ductile iron (cement lined)	Ductile iron (cement lined)	H	150	2
Vent	V	All	PVC	PVC	H	20	2
Chemical vent	VC	All	PVC	PVC	H	20	2

Potable water	W1 & W2	3 and under	Copper type L/PVC	Copper type K	H	150	2
Non- Potable Plant Water	W3	3 and under	PVC/316 SS/Ductile iron (cement lined)	NA	H	150	2**
		4 and greater	PVC/Ductile iron (cement lined)	Ductile iron (cement lined)	H	150	2**

NOTES:
* CEL – Ceramic Epoxy Lining (See Paragraph 2.1-O for specifications)
**For HDPE pipe specifications, refer to Section 15063.
*** H – Hydrostatic
Refer to construction drawings to identify project-specific pipe services.

END OF SECTION

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SECTION 15063

HIGH DENSITY POLYETHYLENE PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, test, and place in satisfactory service the High Density Polyethylene (HDPE) process pipe and fittings as shown.
   2. The extent of HDPE pipe and fittings to be furnished is shown on the Drawings and in the Piping Schedule included in Section 15060.

B. Coordination:

   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the HDPE process pipe Work.

C. Related Sections:
   1. Section 02200, Earthwork.
   2. Section 03300, Cast-In-Place Concrete.
   3. Section 15060, Piping and Appurtenances.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, Inc., (ASTM).
      a. ASTM D 638, Test Method for Tensile Properties of Plastics.
      b. ASTM D 696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between - 30°C and 30°C with a Vitreous Silica Dilatometer.
      c. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
      d. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
      e. ASTM D 1238, Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
      f. ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

g. ASTM D 1505, Test Method for Density of Plastics by the Density-Gradient Technique.
h. ASTM D 1525, Test Method for Vicat Softening Temperature of Plastics.
i. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
j. ASTM D 1599, Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.
k. ASTM D 1603, Test Method for Carbon Black in Olefin Plastics.
l. ASTM D 1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
m. ASTM D 2122, Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.
n. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
o. ASTM D 2290, Test Method for Apparent Hoop Tensile Strength of Plasticor Reinforced Plastic Pipe by Split Disk Method.
q. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
r. ASTM D F2620, Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
s. ASTM D 2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
t. ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
u. ASTM D 3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR), Based on Controlled Outside Diameter.
v. ASTM D 3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
w. ASTM D 3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
x. ASTM F 412, Terminology Relating to Plastic Piping Systems.
y. ASTM F 714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
z. ASTM F 1473, Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipe and Resins.
aa. ASTM F 2206, Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE)

2. American Water Works Association, (AWWA).
   a. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch, for Water Service.
   b. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution.
3. National Science Foundation, (NSF).
   NSF 14, Plastics Piping Components and Related Materials.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantial similar type materials and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
   2. HDPE process pipe, fittings and fusion equipment shall be provided by a single supplier.
   3. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance Program responsible for inspecting incoming and outgoing materials.
   4. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance program responsible for assuring the long-term performance of materials and products ISO 9001 or equivalent.
   5. The HDPE process pipe and fitting manufacturer shall maintain permanent Quality Assurance/Quality Control (QA/QC) records. ISO 9001 or equivalent.

B. Installer's Qualifications:
   1. Engage a single installer regularly engaged in HDPE process piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
   2. Engage a single installer for the entire HDPE process piping system with undivided responsibility for performance and other requirements.

C. Component Supply and Compatibility:
   1. The HDPE pipe and fittings manufacturer shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
   2. All components shall be specifically constructed and manufactured in accordance to ASTM standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Details of piping system including location of supports, restraints, fittings, anchors, vents, low-point drains, termination assemblies and all accessories necessary for piping system.
      b. Pipe laying schedules.
   2. Product Data:
      a. Details of construction, fabrication, and pipe materials.
      b. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
   3. Testing Plans, Procedures, and Testing Limitations: Pipe testing procedures.

B. Informational Submittals:
   1. Certificates:
      a. Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards as required in Article 2.4, below.
      b. Upon shipment, CONTRACTOR shall furnish the HDPE pipe manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the Project are in accordance with the requirements of this Section and a manufacturer's warranty covering materials and workmanship of the HDPE piping.
   2. Suppliers Instructions: Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
   3. Qualifications Statements: Installer's qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site or tag/separate damaged materials and replace with acceptable material.

B. Storage:
   1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
   2. Cover HDPE pipe and fittings stored outdoors.

C. Handling:
   1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
   2. Avoid unnecessary handling of pipe.
   3. Keep pipe interiors free from dirt and foreign matter.

PART 2 - PRODUCTS

2.1 SYSTEM PERFOMANCE

A. HDPE piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the designated service conditions set by the OWNER and ENGINEER (reference design criteria table below).

B. Design Criteria:

Line Service Type:	Sludge (SL)
Pipe Sizing Classification	DIPS
Dimension Ratio (DR)	DR17

2.2 PHYSICAL PROPERTIES

A. Materials used for the manufacture of polyethylene pipe and fittings shall meet the following physical property requirements:

	Property	Unit	Test Procedure	Value
1.	Material Designation	-	PPI/ASTM	-
2.	PPI Material Listing	-	PPI TR-4	PE 4710
3.	Minimum Cell Class	-	ASTM D 3350	355434C
4.	Density	g/cm3	ASTM D 1505	>0.941
5.	Melt Index (E)	g/10 min	ASTM D 1238	<0.15
6.	Flexural Modulus	psi	ASTM D 790	>110,000
7.	Tensile Strength	psi	ASTM D 638	<160,000
8.	PENT	hours	ASTM F 1473	>500
9.	HDB	psi	ASTM D 2837	1,600 @ 23°C
10.	UV Stabilizer (C)	percent carbon black	ASTM D 1603	2 to 3
11.	Elastic Modulus	psi	ASTM D 638	110,000
12.	Brittleness	Temperature F	ASTM D 746	<-150
13.	Vicat Softening	Temp F	ASTM D 1525	255
14.	Thermal Expansion	in/in/ F	ASTM D 696	8 x 10E-5
15.	Hardness	Shore D	ASTM D 2240	64

B. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Article 2.4, below.

C. The HDPE pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

D. Clean rework or recycled material generated by the manufacturer's own production may be used as long as the pipe or fittings produced meet all the requirements of this Section.

2.3 PIPE AND FITTINGS

A. Dimensions:
   1. Pipe Dimensions: The nominal inside diameter of the pipe shall be true to the specified pipe size in accordance with AWWA 901 and AWWA C906 and dimensions specified herein. Standard laying lengths shall be 50 feet ± 2-inches.
   2. Fitting Dimensions: Fittings such as couplings, wyes, tees, adapters, etc. for use in laying pipe shall have standard dimensions that conform to ASTM D 3261. For mitered fittings that are fabricated rather than molded, conform to ASTM F 2206.

B. Pipe and fittings shall be produced from identical materials, meeting the requirements of this Section, and provided by the same supplier. Special or custom fittings may be exempted from this requirement.

C. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by ENGINEER. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

D. Molded fittings shall meet the requirements of ASTM D 3261 and this Section. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. The manufacturer shall provide an explanation of the production codes used.

E. Reducing tees with branch diameters of 16-inches or less shall be saddle tees.

F. Marking:
   Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information.
   1. ASTM or AWWA Standard Designation.
   2. Pipe Size.
   3. Class and Profile Number.
   4. Production Code.
   5. Standard Dimension Ratio (SDR).

2.4 SOURCE QUALITY CONTROL

A. At a minimum, incoming polyethylene materials shall be inspected for density in accordance with ASTM D 1505 and melt flow rate in accordance with ASTM D 1238. All incoming polyethylene materials shall be certified by the supplier. Certification shall be verified by CONTRACTOR and ENGINEER. Incoming materials shall be approved by Manufacturer's Quality Assurance Program before processing into finished goods.

B. Representative samples of polyethylene materials shall be tested against the physical property requirements required herein. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D 1598.

C. Quality Assurance test for representative pipe and fitting samples shall include:

Test	Standard	Pipe	Fittings
Ring PENT	ASTM F 1473	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress: (f_o>100 h)	ASTM D 1598	Yes	Yes
Sustained pressure at 73°F/1,600 psi hoop stress: (f_o>1000 h)	ASTM D 1598	Yes	Yes

D. The HDPE pipe and the molded fitting manufacturer shall certify that samples of their production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe and fitting manufacturer to be 1,600 psi at 73.4°F and 1000 psi at 140°F.

E. Material shall be listed in the name of the HDPE pipe and fitting manufacturer as required by the Plastics Pipe Institute (PPI) in PPI TR-4 with the following Standard Grade ratings:

	73.4°F	140°F
1. Hydrostatic Design Basis (HDB)	1,600 psi	1000 psi
2. Hydrostatic Design Stress (HDS)	1000 psi	500 psi

PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.

F. Inspection Requirements:
1. Certification: As the basis of the acceptance of the material, the manufacturer will furnish a certificate of conformance of these Specifications upon request. When prior agreement is being made in writing between ENGINEER, CONTRACTOR and the manufacturer, the manufacturer will furnish other conformance certification in the form of affidavit of conformance, test results, or copies of test reports.
2. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Manufacturer's Quality Control Program shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst in accordance

with ASTM D 1599 or ring tensile strength in accordance with ASTM D 2290. Molded fittings shall be subject to tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment.

G. Physical Test Requirements:
   1. Sampling: The selection of the sample of pipe shall be as agreed upon by the ENGINEER, CONTRACTOR and the manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate.
   2. Sample size for flattening test will be one sample for each size and class of pipe for the Project.
   3. Conditioning: Conditioning of samples prior to and during test shall be as agreed upon by the ENGINEER, CONTRACTOR and manufacturer. In case of no prior agreement, the conditioning procedure used by the manufacturer shall be deemed adequate.

H. Test Methods:
   1. Flattening: Three specimens of pipe, a minimum of 12-inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes. Remove the load, and examine the specimens for splitting cracking or breaking.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to these Specifications or following:
   1. Fractures or cracks passing through pipe wall shall not be accepted. Pipes within one shipment shall be rejected if defects exist in more than five percent of shipment or delivery.
   2. Cracks sufficient to impair strength, durability or serviceability of pipe.
   3. Defects indicating improper proportioning, mixing, and molding.
   4. Damaged ends, where such damage prevents making satisfactory joint.
   5. Gouges or scrapes exceeding ten percent of the specified wall thickness. Removal of damaged section is acceptable.

B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at Site and documentation of conformance to these Specifications.

C. CONTRACTOR to provide as-built of pipe end point and angle point coordinates and elevations prior to backfilling trench.

3.2 INSTALLATION

A. Install piping as shown, specified, and as recommend by pipe and fittings manufacturer. Refer to Drawing details and Section 02200, Earthwork for Trench Excavation and Backfill requirements. For pipe bedding, refer to Drawing details.

B. Heat Fusion of Pipe:
   1. HDPE pipe and fittings joints shall be heat fused by a qualified technician; trained by the manufacturer's representative in accordance with ASTM F 2620 and the manufacturer's recommended fusion procedures. Training must have occurred within the previous 12 months, or submittals verifying experience within the previous 12 months for all technicians performing heat fusion on polyethylene pipe and fittings.
   2. Weld in accordance with ASTM F 2620 and manufacturer's recommendation for butt fusion methods. Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.
   3. The first butt fusion weld of each day's production welding and for each separate operator shall be tested by bent strap or guided side bend test method. No production welds shall be performed until successful completion of above testing.
   4. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by HDPE pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. The equipment used for the heat fusion joints shall be capable of recording the heating and fusion pressures used to join the HDPE pipe, recording heater temperature, and storing this information for future retrieval (data logger). Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports. Log reports shall be submitted to CONTRACTOR and ENGINEER daily. Reports shall also include the results of the bent strap tests.
   5. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.
   6. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade. Shop Drawings shall address locations and deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.
   7. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
   8. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures.
   9. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
   10. Cover open ends of fused pipe at the end of each day's Work. Cap to prevent entry by animals or debris.

C. Flange Jointing:

1. Use on flanged pipe connection sections.
2. Connect slip-on Type 316 stainless steel backup flanges with Type 316 stainless steel nuts and bolts.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints.
    a. Align flanges or flange/valve connections to provide tight seal. Require nitrile-butadiene gaskets if needed to achieve seal. Integral flange adapters and gaskets are required for flange/valve connections.
    b. Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with PPI TN-38 and manufacturer's recommendations.
    c. Tighten flange bolts in sequence and accordance with manufacturer's recommendations. CAUTION: Do not over-torque bolts.
5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendation.
6. Properly align flange faces prior to assembly. Do not use bolts to draw flange faces together.
7. Install electrofusion couplers, where used, in accordance with manufacturer's specifications.

D. Pipe Placement:
1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations and standards and requirements listed in AWWA M55.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe DR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 feet.
5. Cap pipe sections longer than single joining (usually 50 feet) on both ends during placement, except during fusing operations.
6. Notify ENGINEER prior to installing pipe into trench and allow time for ENGINEER'S inspection.
    a. Correct irregularities found during inspection.
7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
11. Pipe shall be snaked in trench to allow a minimum of 12-inches/100 feet for thermal contraction and expansion.

12. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.

E. Saddle tees 4-inches and smaller may be field fabricated. Field fabrication may only be performed by persons trained and certified by the manufacturer. Submit certification of qualified persons before fabricating any saddle tees. Saddle tees larger than 4-inches must be factory manufactured.

3.3 HDPE PIPE TESTING

A. Hydrostatic Testing: For HDPE pipe, follow procedures described in ASTM F2164. Test duration, including time to pressurize, time for initial expansion, time at test pressure and time to depressurize, shall not exceed eight hours. If re-testing of a test section or pipeline is required, at least eight hours shall elapse between tests.
B. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
C. Test Procedure: Per standards in PPI TN-46.
D. Allowable Leakage Rates: No leakage – pipe with flanged, welded, fused, threated, soldered, or brazed joints. In addition, there shall be no visible leakage.

END OF SECTION

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SECTION 15097
SEISMIC RESTRAINTS FOR PIPING

PART 1 – GENERAL

1.1 SCOPE

A. Scope: This section specifies seismic restraints for bracing all piping systems specified in Section 15060. This section does not include seismic restraints for fire sprinkler systems.

B. Definitions:

1. Longitudinal direction--direction parallel to the pipe axis.

2. Lateral direction--direction perpendicular to the pipe axis.

C. Operating Conditions:

1. The seismic restraints specified in this section are intended to resist pipe movements and loads occurring as a result of an earthquake or other seismic event. Unless otherwise specified, all piping shall have bracing to resist seismic loading caused by forces applied at the individual pipe's center of gravity.

2. All piping systems shall be provided with seismic restraints conforming to governing state and local codes. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

D. Restraint Selection:

1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Paragraph 15060-1.7, this work shall be the product of a Design Professional retained by the Contractor.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

3. Seismic restraints may be omitted from the following installations:

a. Gas piping less than 1-inch inside diameter.

b. All other piping less than 2 1/2-inch inside diameter.

4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake.

Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper-plated, rubber, plastic or vinyl coated, or stainless steel restraint components.

7. Branch lines shall not be used to brace main lines.

8. Seismic bracing shall not limit the expansion and contraction of the piping system.

E. Related Work Specified Elsewhere

1. Section 15050

2. Section 15056

3. Section 15060

1.2 QUALITY ASSURANCE

A. References:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A58.1-82	Minimum Design Loads for Buildings and Other Structures
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
FEDSPEC WW-H-171e-78	Hangers and Supports, Pipe
MFMA-2-91	Metal Framing Standards Publication
MSS SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture
MSS SP-69-91	Pipe Hangers and Supports - Selection and Application
SMACNA, PPIC	Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems

B. Design: The seismic restraint system shall be designed by the Design Professional retained under Paragraph 15060-1.7. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in Section 15060. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

PART 2 – PRODUCTS

2.1 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Aickin Corporation, Carpenter & Patterson, B Line, Kin-Line, Anvil International (ITT Grinnell), Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or Equal. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP-58, MSS-SP-69, MSS-SP-89, MFMA-1, and MFMA 101.

2.2 MATERIALS

General: Unless otherwise specified, restraints shall be manufactured of the same materials specified for the hangers and supports in the Area of installation, as specified in Section 15056.

2.3 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 15056-2.3.

Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.4 PRODUCT DATA

The following information shall be provided in accordance with Section General Conditions:

A. Seismic restraint system drawings and calculations as specified in paragraph 15097-1.2 B.

B. Seismic restraint locations and legend as specified in paragraph 15097-3.1.

C. The Design Professional's reports and certification of final installation as specified in paragraphs 15060-1.7 and 15097-3.3.

PART 3 – EXECUTION

3.1 PIPE RESTRAINT LOCATIONS

A. The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

B. Ductile and cast iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

C. No-hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

D. Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

E. Seismic restraint locations and components shall be indicated on the piping layout drawings required by Section 15060. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of Section 15060 and paragraph 15097-1.2 B.

3.2 INSTALLATION

A. Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

B. Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

C. Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

D. Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging. Otherwise, anchor bolts shall be designed and provided in accordance with Section 05051.

E. The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

F. Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

G. Rollers shall roll freely without binding.

H. Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.3 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 15060-1.07 and 15097-1.02 B shall inspect the seismic restraint system during construction, at the intervals specified in Section 15060, and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 15056 requirements.

END OF SECTION

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SECTION 15100

VALVES AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. The work covered by this Section includes furnishing all labor, materials, equipment and incidentals required to furnish, install and test all valves and appurtenances as shown and specified and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other Section of these specifications. Items to be provided include but shall not be limited to the following:
   1. Valves.
   2. Operators, floor stands and valve boxes.
   3. Yard Hydrant

B. Related Work specified elsewhere:
   1. Section 09900 - Painting.
   2. Section 15050 – Basic Mechanical Materials and Methods
   3. Section 15060 - Piping and Appurtenances.
   4. Division 17 – Instrumentation and Controls

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 considered as being included in the price bid for the Work shown as specified.

1.2 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:
   For each type and model of valve, provide:
   1. Assembly instructions and spare parts list.
   2. Preventative/corrective maintenance instructions.
   3. Certificate of seat compatibility with entailed fluid exposure.
   4. Documentation of current backflow preventer certifications.

B. Erection Drawings. Erection drawings shall include the procedures to be used in setting, supporting, and/or anchoring the valves, the fitting of line

pipe to the valves for proper coupling, and for adjusting and testing all valve assemblies.

PART 2 - PRODUCTS

2.1 OPERATORS

A. All valves shall be equipped with operators. The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations. The responsibility for proper operation shall reside with valve supplier. When the maximum force required to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided. Gear operators shall be totally enclosed and lubricated. All valves shall open by turning counterclockwise. Materials of construction for valve operators shall be as recommended by the manufacturer for the intended environment and service. Valves shall be installed with extension stems and valve boxes, as required.

B. Manual Actuators:

1. Multi-turn Operators: All multi-turn valves shall be fitted with handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.
2. Chainwheel Operator: All Valves six feet or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel or lever operator and shall be the valve manufacturer's standard, with 316 SS chain to be furnished in the length required for operation.
3. Wrench Nut Operation: An AWWA nut or shaft key, as applicable shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or as indicated on the Drawings. Nut shall be constructed of cast iron. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall insure permanent watertightness.
4. Buried Service Operators:
    a. Buried service operators on valves larger than 2- ½ inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. All moving parts of the valve and operators shall be enclosed in a housing to prevent contact with the soil.
    b. Buried service operators for quarter-turn valves shall be designed to withstand 450 foot-pounds of input torque at the fully open or fully closed positions without damage to the valve or operator and shall be grease packed and gasketed to withstand a submersion in water to 10psi.

5. Quarter-turn Operators:
    a. The valve operators shall be of the self-locking type to prevent the disc or plug from creeping and shall be provided with position indicators to show the position of the valve disc or plug.
    b. Operators of the worm and gear type shall have self-locking worm gears, one-piece design, of gear bronze material, accurately machine cut. The worm shall be hardened alloy steel with thread ground and polished.
    c. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile nut.

C. Electric Actuators for metal bodied valves shall be provided as specified in Section 15109, Electric Motor Actuators and Appurtenances.

D. Electric Actuators for Thermoplastic Butterfly Valves: New electric actuators shall have a thermally protected, bi-directional (reversing type), capacitor-run motor with a permanently lubricated gear train. 115 VAC and 230 VAC motors shall conform to CE and be indicated on motor housing. Actuator shall have solid, heat treated gearing encompassed in a baked powder coated die cast aluminum housing with thermally bonded powder coat finish with stainless steel trim rated Type 4X. Each actuator to have a declutchable manual override, visual position indication, ISO mounting configuration, and be RoHS compliant. Acceptable manufacturers are:
    1. Series 92 by Asahi-America, Inc.
    2. Or Equal

E. Electric Actuators for Thermoplastic Ball Valves: Actuators shall be Series 92 by Asahi. All open/close electrically actuated ball valves, sizes 1/2" through 4", shall have direct mounted unidirectional quarter-turn actuators (120 VAC and 230 VAC, 12/24 VAC/VDC shall be reversing). Actuator shall be rated Type 4X design with gasket cover to base seal, captive cover screws, (1) 1/2" NPT conduit fitting with wires protruding 6" for customer hook-up and O-ring or gasket to valve seal. A green wire lead shall be provided for grounding purposes. The actuators shall be factory equipped with Omni®, Type-21 or Type-23 ball valves, as manufactured by Asahi/America, Inc

F. Electric Actuators for Thermoplastic Globe-style Control Valves: Actuators shall be MV-1010 Series by Jordan Controls (Rotork) and shall be as recommended by the valve manufacturer for the intended service.

2.2 SOLENOID VALVES

Two-way solenoid valves shall have stainless steel bodies, Teflon seals and disks, with, 120 VAC, 60 Hz operated solenoid coils. All coils shall be housed in NEMA

4X cases with provision for ½-inch electrical conduit. Specific solenoid valves to be provided are shown on the drawings. Acceptable manufacturers are

A. ASCO

B. Skinner

C. Magnetrol

D. or equal.

2.3 METAL BODY VALVES

A. Gate Valves:

1. Metal gate valves 1 ½ inches in diameter and smaller: 125 psig; bronze; rising-stem; single-wedge; disc type; screwed ends; Crane No. 428, or Equal.
2. Metal gate valves 2-inches through 12 inches in size shall be resilient-seated, non-rising stem type with 2-inch operating nuts for buried service and handwheels for exposed service conforming to AWWA Standard C-509, as manufactured by American Flow Control, Kennedy Valve Co., Clow Valve, or Equal.

B. Ball Valves:

1. Bronze ball valves up to 1-1/2-inch (incl.) in size shall have bronze 2-or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Metal ball valves 2-inch to 4-inch in size shall have bronze 2-or 3-piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated. The balls shall be solid chrome plated brass or bronze, or stainless steel, with full port openings. 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. Ball valves shall be as manufactured by Conbraco Industries, Inc. (Apollo); ITT Engineered Valves; Neles-Jamesbury, Inc; NIBCO, Inc., or Equal.

2. Stainless steel ball valves up to and including 2-inches in size shall be of stainless steel construction with threaded or flanged connections. Body shall be of Type 316 stainless steel, 3-piece construction, full port opening, with slide-lock handle. Minimum working pressure shall be 250 psi. Body bolts, nuts, washers shall be 18-8 or series 300 stainless steel. Seat, seals, and stem bearing shall be PTFE. Balls and stems shall be of type 316 stainless steel. Ball valves shall be as manufactured by Jamesbury (Metso), Apollo, or Equal.

C. Metal Needle Valves

1. General: Metal Needle valves shall be rated for a minimum working pressure of 150 psi at a temperature of 125 deg. F, unless otherwise specified.
2. Materials of Construction: Needle Valves for water service shall be 316 stainless steel body, regulating type stem, with PTFE packing. The stem shall be 20 pitch fine thread (five turns from closed to fully open).
3. Manufacturers:
    a. Apollo,
    b. Smith Cooper,
    c. Parker,
    d. Or Equal.

D. Eccentric Plug Valves

1. Plug valves shall be of the non-lubricated, eccentric type with resilient faced plugs, and full port area. End connections shall be flanged for exposed plug valves. End connections shall match adjoining pipe for buried service (restrained mechanical joint – with adapters as needed for installation in HDPE buried lines). The body shall be of semi-steel (ASTM A-126 C1.B) and shall have bolted bonnet, which gives access to the internals of the valve. Seats shall be welded overlay of high nickel content or a stainless steel plate locked in the body cavity. If a plate is used, it shall be replaceable through the bonnet access. Plugs shall be fully encapsulated in Chloroprene. Bearings shall be Type 316L stainless steel. Thrust bearing shall be PTFE. Bearing areas shall be isolated from the flow with grit seals. Valves shall have packing bonnets where the shaft protrudes from the grit seals. Valves shall have packing bonnets where the shaft protrudes from the valve and the packing shall be self-adjusting chevron type, which can be replaced without removing the bonnet. All nuts, bolts, springs and washers shall be Type 316 stainless steel.
2. Exterior surfaces, except finished or bearing surfaces, shall be carefully prepared by removing dirt, grease, and rust and shall be cleaned to the extent that the coating will bond to the surfaces. 12 mils minimum (non-stainless steel parts) of Blue Epoxy Tnemec 141 (NSF 61) on interior (SP5 surface prep) and 3 mils minimum (non-stainless steel parts) of Blue Enamel (NSF 61) on exterior (SP10 surface prep). The primer shall be compatible with the anticipated field coatings. Flange faces shall be protected from atmospheric corrosion.
3. Valves shall be designed for a working pressure of 150 PSI. The valve and actuator shall be capable of satisfactory operation in either direction of flow against pressure drops up to and including 150 PSI. Valves shall be bubble tight in both directions at 150-psi differential.

4. Valves 4-inches and smaller shall be provided with hand lever operators. Operators shall have heavy-duty cast iron bracket, cast iron latching lever, and self-lubricating bushings and shall be capable of securing the valve in any position.
5. Valves 6-inches and larger in diameter shall have worm gear operators. Rotary operators shall have a heavy-duty, weatherproof cast iron or steel housing with gasketed, removable cover and shall be equipped with a mechanical dial or slot type position indicator and suitable hand wheel. Manual operators shall be totally enclosed and sealed to prevent the entrance of rain, dirt, and corrosive atmospheres. Worm gear operators shall have hardened, grease-lubricated alloy steel worms and bronze worm gears. All exterior bolts and fasteners shall be stainless steel for corrosion resistance. The valve shall open with counterclockwise rotation of the hand wheel.
6. Valves located more than 6 feet above the working surface shall have a rotary operator with chainwheel. Operating nuts for buried valves shall be standard 2" square nuts and shall conform to AWWA C500. Extension stems, valve boxes, and stem guides shall be furnished as required for proper operation.
7. Plug valves are to be installed in accordance with the manufacturer's recommendations for the service conditions.
8. Manufacturers: Clow Valve Co., DeZurik Corporation, Pratt, or Equal

E. Check Valves
1. Swing check valves for water, sewage, sludge, and general service shall be resilient-seated and of the adjustable outside lever and weight type, in accordance with ANSI/AWWA C 508 - Swing-Check Valves for Waterworks Service, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 175 psi. They shall have a flanged cover piece to provide access to the disc. Where indicated on the drawings provide double lever and weight assemblies.
2. Interior Coating: Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coating in accordance with AWWA C550. Min. 8 mils of NSF 61 epoxy coating inside valve.
3. Provide valves suitable for horizontal or vertical mounting.
4. Valve seats shall be mechanically attached and shall be field replaceable.
5. Body: The valve body and cover shall be of cast iron conforming to ASTM A 126, with flanged ends conforming to ANSI B 16.1, or as shown in the Drawings.
6. Disc, Cover, Gland, Disc Arm: Shall be of cast iron or ductile iron.
7. Seats and Rings: Body seat shall be Type 316 stainless steel held in place with stainless steel set screws. Disc seat shall be Buna-N

rubber and follower ring shall be stainless steel. Body seat and disc seat must be field replaceable without removing valve from the pipe. O-rings shall be Buna-N rubber.

8. Hinge Shaft, Hinge Shaft Bushings, Shaft End Plate: Shall be of Type 316 stainless steel.
9. Disc Center Pin Assembly: Type 316 stainless steel
10. Internal and external bolting and other associated hardware: Type 316 stainless steel
11. Gland Packing: Graphite and Kevlar
12. Manufacturers: DeZurik, Crispin Valve, GA Industries, Crane, or equal.

F. Backflow Preventer: 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. .

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 code.
2. Sizes ¾-inch through 2-inches shall have bronze bodies with threaded connections, a bronze union on either side and a strainer 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.

G. Pressure Reducing Valves:

1. Metallic pressure reducing valves shall be bronze body, spring controlled, adjustable pressure reducing valve with threaded connections. Provide valves with high temperature diaphragm and renewable nickel alloy seat. Provide with thermal expansion bypass. Provide with separate bronze strainer with 20 mesh 316 stainless steel basket. Attach to valve with bronze nipple. Valves

shall be rated for 300 psig maximum inlet water pressure with adjustable 25-75 psig outlet water pressure.

2. Pressure reducing valves shall be Watts LF223SB or approved equal.

H. Pressure Relief Valves:

1. Pressure relief valves for potable water or plant water service shall be bronze body with threaded inlet and outlet to standard NPT and with flanged top, suitable for an inlet pressure of 300 psi. The valve shall open when the inlet pressure exceeds a set maximum level. It shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a spring and hydraulically operated, direct acting, adjustable, diaphragm or piston type globe or angle valve as indicated. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting. The valve trim shall be of stainless steel with stainless steel spring. The rubber seat shall be replaceable. The valve shall be settable for a minimum relief pressure of 25 psi.
2. Pressure relief valves shall be equal to Cla-Val Company, OR Golden-Anderson OR Ross Valve Mfg. Co., Inc.

I. Pressure Sustaining (Backpressure) Valves:

1. Backpressure valves for wastewater sampling service shall be bronze body with Class 125 flanged inlet and outlet. Valve shall be angle body. Stem and seat shall be stainless steel. Valve shall have an externally mounted speed control pot. Valve spring shall be rated for 20 lb/in with a top end set point of 30 psig.
2. Backpressure valves shall be 2" model 70 SWR by Ross Valve Co., or Equal.

J. Pinch Valves:

1. General:
   Pinch valves shall be of the mechanical pinch type with flexible sleeve designed for drip tight shut-off. The valve length shall be as given in ISA S75.08. Pinch valves shall be of the Series 5200 as manufactured by the Red Valve Co., Inc., or approved equal.
2. Construction
   a. Valves shall be full cast ductile iron body with flange joint ends. The flanges shall be drilled and tapped to mate with ANSI B16.1, Class 125 / ANSI B16.5, Class 150 flanges.
   b. The sleeve trim shall be one piece construction with integral flanges drilled to be retained by the flange bolts. The sleeve trim shall be reinforced with calendared nylon or calendared polyester fabric to match service conditions. The sleeve trim shall be connected to the pinch bar by tabs imbedded in the sleeve trim reinforcing ply. All internal valve metal parts are to be completely isolated from the process fluid by the sleeve

trim. For full port and reduced port sleeves the port areas shall be 100% of the full pipe area at the valve ends. For Cone and Variable Orifice sleeves the port area at the inlet shall be 100% of the full pipe area, reducing to a smaller port size at the outlet.

c. The solid steel pinch mechanism shall be single acting, closing the sleeve from the top only. The mechanism shall be supported in the valve body. There shall be no cast parts in the operating mechanism. The mechanism shall be connected to the electrically actuated actuator through an ACME threaded stem. The pinch mechanism shall be adjustable for stroke without removing the valve from the line.

K. Air Release Valves for Sludge Service

1. General

a. Air release valves shall have an elongated body and be designed to operate (open) while pressurized allowing entrained air in a sludge pressure line to escape through the air release orifice without spillage or spurt. After entrained air escapes through the air release orifice, the valve orifice shall be closed by an adjustable orifice button on a compound lever mechanism to prevent media from escaping. The air release orifice shall remain closed until more air accumulates and the opening cycle repeats automatically. The air release valve shall be provided with inlet shut-off valve and blow-off valve (Type 316 SS Ball Valve), a back-flush valve with quick-disconnect coupling and flushing hose with quick-disconnect connections. Air release valves shall be as manufactured by APCO, Val-Matic, or equivalent.

b. Air release valves shall not admit air into the piping system to which they are attached when the internal pressure drops below the operating pressure or becomes negative gauge.

c. Air release valves for sludge service shall be sewage type with elongated body and float stem. Sewage type ARVs shall be suitable for service of process fluids with 1-2% solids content.

2. Construction

a. Provide single body type Air release valves.

b. Air release valve body and cover shall be cast iron in accordance with ASTM A126, Grade B or ductile iron ASTM A536, Grade 65-45-12 or ASTM A351, Grade CF8M stainless steel. 2” through 4” valves shall have N.P.T. threaded inlets. Internal linkage, stem, and float shall be Type 316 stainless steel. Seat and other elastomers shall be Buna-N or EPDM. If valve body is not stainless steel, valve

interior and exterior shall be coated with fusion bonded epoxy per AWWA C550.

c. Orifice size shall be manufacturer's standard size. Orifice is defined as the opening in valve mechanism through which air is expelled from pipeline or piping system.

d. Valve design pressure shall be 75 psig minimum.

e. Operating pressure range shall be 1 to 20 psig. Furnish low durometer orifice button.

L. Butterfly Valves for Plant Water

1. Manufacturers: Provide products of one of the following:
   a. DeZurik,
   b. Henry Pratt Company,
   c. Or Equal.
2. General:
   a. Provide butterfly valves as specified herein.
   b. Lug - style
   c. Rated Working Pressure: Min. 150 psig, Class 150B.
   d. Maximum Fluid Temperature: 150 degrees F.
   e. Valves shall provide drip-tight, bi directional shutoff at rated pressures.
   f. Mount valves seats in valve body.
   g. Valves shall be capable of being maintained in open or partially open position for manual operation, and for automatic operation. When valve disc is maintained, there shall be no chatter or vibration of disc or operating mechanism.
   h. Valve packing shall be replaceable without dismantling valve.
   i. Disc shall be offset form shaft to provide uninterrupted 360-degree seat seal.
3. Materials of Construction: materials of construction shall be as follows:
   a. Body: Cast-iron, ductile iron or alloy cast-iron
   b. Shaft: Type 316 stainless steel
   c. Discs: Cast-iron or ductile iron
   d. Seats: Buna-N or other synthetic rubber suitable for the application.
   e. Seating Surfaces: Type 316 stainless steel
   f. Bearings: Valves Smaller than 6-inch Diameter: Nylon
   g. Shaft Seals: Externally adjustable, material same as for seats. For services that are either buried or submerged, self-adjusting V-type chevron, material same as for seats.
   h. Tapered Pins for Attachment of Shaft to Disc: Type 316 stainless steel.

i. Internal and external bolding and other hardware; including pins, set screws, studs, bolts, nuts and washers shall be Type 316 stainless steel.

4. Interior Coating:
   a. Valves shall be coated inside. Steel, Cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy-coated.
5. Testing:
   a. Test each valve in the manufacturer's shop in accordance with manufacturer's requirements.
6. Gear Actuators for Manual Valves:
   a. Provide gear actuators conforming to AWWA C542.
   b. Gear actuators for valves shall be constructed for 150 psi differential pressure and 16 feet per second port velocity.

M. All miscellaneous fittings, valves, nipples, and accessories in contact with the chemicals shall be compatible with the chemical handled.

N. Spares:
1. Provide one spare valve of each type and size.
2. Provide one spare actuator of each type.

2.4 THERMOPLASTIC VALVES

A. Gate Valves:
1. Thermoplastic gate valves shall be constructed of high impact PVC and have no metal to media contact. The gate shall be a tapered cylindrical plug design. PVC shall conform to ASTM D1784 Cell Classification 12454-A, and PP to ASTM D4101 Cell Classification PP0210B67272. Valves shall have a pressure rating of 150psi at 70º F sizes 1-1/2" through 8", 110psi at 70º F size 10", and 75psi at 70º F sizes 12" and 14". The valve shall have a non-rising stem, come standard with sealed position indicator, clean-out plug and FKM seals, as manufactured by Asahi/America, Inc., or Equal.

B. Ball Valves:
1. Plastic ball valves shall be made of polyvinyl chloride (PVC). Balls shall be of the same material as the body and shall have full size ports and concave Teflon seats designed to absorb expansion. Provide Viton back up cushions to absorb expansion. All body seals, union O ring seals, and stem seals shall be of Viton, containing a minimum of 55% Viton. The valves shall be suitable for a maximum working non-shock pressure of 230 psi at 70 degrees F for PVC. Ball valves for NaOCl service shall have a 1/8" vent hole on the upstream side of the ball. Ends shall be of the true union design with integral union nuts on both ends of valve. Threads between union

nuts and valve body shall be deep molded square ACME threads to protect against pipeline expansion and water hammer stresses. Ball valves shall be as manufactured by ASAHI-America; George Fischer, Inc.; NIBCO Inc./Chemtrol; Hayward or Equal.

C. Plastic Needle Valves
   1. General: The valve shall be rated for a minimum working pressure of 150 psi at a temperature of 120 deg. F, unless otherwise indicated.
   2. Materials of Construction: Plastic Needle Valves shall be globe-style with bodies made from PVC and threaded ends. The valve shall include a Teflon (PTFE) stem seal. The stem shall be 20 pitch fine thread (five turns from closed to fully open).
   3. Manufacturers:
      a. Chemline,
      b. Spears,
      c. Or Equal.

D. Pressure Relief Valves:
   1. Thermoplastic pressure relief valves for sodium hypochlorite service shall be angle-pattern style with PVC body and PTFE shaft. All wetted materials shall be non-metallic. Seals shall be FKM (Viton). Relief pressure shall be adjustable from 5-125 psi. Threaded connections. Valves shall be Series RVT by Plast-o-matic Valves, Inc., or Equal.

E. Backpressure Valves:
   1. Thermoplastic 1- to 2-inch backpressure valves for sodium hypochlorite service shall be in-line style with PVC body and seat. All wetted materials shall be non-metallic. Seals shall be FKM (Viton). Relief pressure shall be adjustable from 5-100 psi. Threaded connections. Valves shall Series RVDT by Plast-o-matic Valves, Inc., or Equal.
   2. Thermoplastic 3-inch backpressure valves for sodium hypochlorite service shall be angle-pattern PVC body of a rolling-diaphragm design. All wetted materials shall be non-metallic. Control spring shall be plated steel. Seals shall be Viton. Relief pressure shall be adjustable from 5-100 psi. Maximum inlet pressure shall be 150 psi. Threaded connections. Valves shall be Series RVTX by Plast-o-matic Valves, Inc., or Equal.

F. Thermoplastic Air Release Valves: Air Release valves shall be 1-inch Plast-O-matic Series ARV CPVC valves with Viton gaskets as provided by Plast-O-matic Valves, Inc. of Cedar Grove, NJ 07009. Provide valves with threaded connections and Viton seals and gaskets.

G. Thermoplastic Degassing Valves: Degassing valves shall be ½" Plast-O-matic Series DGV CPVC valves with Viton gaskets as provided by Plast-

O-matic Valves, Inc. of Cedar Grove, NJ 07009. Provide valves with threaded connections and Viton seals and gaskets.

H. Thermoplastic Diaphragm Valves: Diaphragm valves shall be Type-14 Flat Faced Flanged design with CPVC body provided by Asahi-America, Inc., or Equal. The valves shall come standard with position indicator, travel stop, and bonnet O-ring sealing arrangement. The valve shall be Weir type, either square or round body/bonnet sealing design, and 1/4 turn bayonet style diaphragm/compressor connection. All PTFE diaphragms shall be 3-layer style with PTFE wetted diaphragm, PVDF gas barrier and EPDM backing cushion. The PVDF Gas Barrier shall be between the EPDM and PTFE layers and prevent against gas migration outside of the valve. Valve stem shall be titanium. Type-14 Diaphragm valves shall have a pressure rating of 150 psi at 70°F.

I. Thermoplastic Butterfly Valves: Butterfly Valves shall be Type-57 CPVC body with PVDF disc and FKM seat & seals provided by Asahi-America, Inc., or Equal. The liner shall be full seat design fully molded around the body whereas only the Disc and Seat are wetted parts and feature raised convex rings on the face and be utilized as the mating flange gaskets. Valve shall have spherical disc design for increased CV, high cycle life, and ultimate sealing. Valve body shall have integral molded body stops and seat relief area to prevent over-tightening of the mating flanges. Valves shall accept flat faced flanges in accordance with ANSI B16.5 bolt pattern for 150 lb flanges. Valve stem shall be titanium, have PP stem retainer for valve stem retention, be non-wetted, and have engagement over the full length of the spherically designed disc. The valve lever handle shall have a molded provision for a padlock. Valves shall feature a molded ISO bolt pattern for accessory mounting. Type-57 Butterfly valves shall have a pressure rating of 150 psi at 70°F

J. Thermoplastic Swing Check Valves: Swing Check Valves shall be PVC body with PTFE seals and shall incorporate a single disc design suitable for horizontal or vertical applications. Valves shall have a top entry bonnet for maintenance purposes. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges. Valves shall be as manufactured by Asahi-America, Inc., or Equal.

K. Thermoplastic Globe-style Control Valves:
   1. Valves shall be flanged split body, globe ANSI style as manufactured by Collins Instrument Company of Angleton, TX.
   2. Valves shall be Model 1070-1-839P01-ADC-6.0P-KSXX or Model 2070-2-839P01-ADC-38.0P-KSSX to match size of existing valves.
   3. Valves shall be constructed of Kynar (PVDF) with 150# flanges.

L. Calibration Column: Calibration columns shall be clear PVC with a vent for use in calibrating the sodium hypochlorite and sodium bisulfite feed pumps.

A flexible portion of clear PVC tubing may be used on the top of the calibration chamber to connect it to the vent. Calibration columns shall be sized for a 30-second draw-down at maximum rated pump capacity.

M. All miscellaneous fittings, valves, nipples, and accessories in contact with the chemicals shall be compatible with the chemical handled.

N. Spares:
1. Provide one spare valve of each type and size.
2. Provide one spare actuator of each type.

2.5 PROTECTIVE COATINGS FOR VALVES

A. Interior. Ductile iron, cast iron, and steel valves with sludge/sewage service shall receive a factory applied ceramic epoxy lined coating of Protecto 401 or equal.

B. Exterior. Field coat exposed valves in conformance with Section 09900, Painting and as specified herein.

PART 3 - EXECUTION

3.1 INSTALLATION

Aboveground valves shall be rigidly held in place using supports and hangers as specified. The stem orientation of valves in elevated piping shall be as approved by the Owner for accessibility, but no valve shall have stem in the downward direction. Saddle type valve supports shall be provided for all valves in vaults. Supports shall be of rugged construction providing at least 120 degrees under-support for the valve body, shall be constructed of steel as specified in Division 5, and shall be anchored to the foundations using anchor bolts.

3.2 TESTS

Field Tests. Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The testing of the hydraulically and electrically controlled valves shall be supervised by a representative of the manufacturer who shall verify proper installation, adjustments, and performance. The adequacy of all pipe hangers and supports and valve supports to meet specified requirements shall be verified. All defects found shall be corrected as approved.

3.3 COORDINATION WITH INSTRUMENTATION

It shall be the responsibility of the Contractor to coordinate with Division 17 regarding the requirements of control valves.

3.4 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

The installation and operation of the valve and motorized actuators shall be the unit responsibility of the valve supplier.

3.5 CLEANING

All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other sections.

END OF SECTION

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SECTION 15109

ELECTRIC MOTOR ACTUATORS, POWERED VALVES AND APPURTENANCES

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies electric motor actuators and provides schedules for valves to be powered for operation including manual valves with position / limit switches and electrically actuated valves. Solenoid valves and electrically actuated thermoplastic valves are specified in Section 15100.

B. Provide electric motor actuators and appurtenances as indicated and specified.

C. Each type of actuators for valves to be the product of one manufacturer.

D. For use in the control valve schedule provided at the end of this Section, the powered actuators and operators are defined as follows:

Actuator Type (ACTUSPEC)	Service	Definition
EMTT	Throttling (Modulating)	Electric motor multi-turn
EQTT	Throttling (Modulating)	Electric motor quarter-turn
EMTI	Isolating (Open-Close)	Electric motor multi-turn
EQTI	Isolating (Open-Close)	Electric motor quarter-turn

1.2 RELATED WORK

A. General Conditions

B. Section 15100 - Valves and Appurtenances

C. Section 16150 - Electric Motors

D. Section 15060 – Piping and Appurtenances

E. Section 17100 – Instrumentation, Control and Monitoring System Loop Descriptions

1.3 REFERENCES

A. NEMA Standards as applicable.

B. American Society for Testing and Materials (ASTM) Publications:
   1. A36: Specification
   2. A48: Specification for Gray Iron Castings.
   3. A322: Specification for Carbon and Alloy Steel Bars.

C. National Electrical Code as applicable.

D. American Water Work Association (AWWA):
   1. C540: Power-Actuating Devices for Valves and Sluice Gates.

E. Anti-Friction Bearing Manufacturers Association (AFBMA):
   1. Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings.
   2. Standard 11-90 Load Ratings and Fatigue Life for Roller Bearings.

1.4 SUBMITTALS

A. Submit the following in accordance with the General Conditions:
   1. Certified shop and erection drawings.
   2. Data, regarding actuator and motor characteristics and performance.
   3. Shop drawing data for accessory items.
   4. Manufacturer's literature as needed to supplement certified data.
   5. Operating and maintenance instructions and parts lists.
   6. Listing of reference installations as specified with contact names and telephone numbers.
   7. Actuator shop test results.
   8. Motor shop test results.
   9. Qualifications of field service engineer.
   10. Schematic control and power wiring diagrams.
   11. Shop and Field inspections reports.
   12. Recommended spare parts other than those specified.
   13. Recommendations for short- and long-term storage.
   14. Special tools.
   15. Shop and field testing procedures and equipment to be used.
   16. Torque settings for each actuator.
   17. Number of service man days provided and per diem field service rate.
   18. Manufacturer's product data and specifications for shop painting including statement of compliance for compatibility with field painting.
   19. Provide a listing of the materials recommended for each service specified and indicated.
   20. ISO 9001 certification.
   21. Material Certification:
      a. Provide certification from the equipment manufacturer that the materials of construction specified are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on

incompatibility with the service conditions, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list of a minimum of five (5) installations in operation for a minimum of three (3) years. Provide proposed materials at no additional cost to the City.

b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. Certificate of Unit Responsibility.

C. A copy of the contract mechanical process, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required."

Failure to include all drawings or a statement application to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

D. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.5 QUALITY ASSURANCE

A. Provide in accordance with the General Conditions and as specified herein.

B. Actuators for all valves, gates and equipment to be the product of one manufacturer.

Contractor to coordinate with all valve, gate and equipment suppliers.

C. Actuators to be manufacturer's standard cataloged product and modified to provide compliance with the specifications and the service conditions specified and indicated.

D. Shop tests as specified.

E. Provide Services of Manufacturer's Representative as stated in Section 01600 and as specified herein.

F. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must have a minimum of five (5) years of experience, all within the last seven (7) years, on the type and size of equipment specified.
2. Service Technician must be present on site for all items listed below. Man-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.
3. Installation: Supervise setting, alignment, field erection; coordination of piping, electrical and miscellaneous utility connections:

   1/8 person-day per actuator.

4. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified.

   1/8 person-day per actuator.

5. Field Performance Testing: Field performance test equipment specified.

   1/8 person-day per actuator.

6. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classrooms sessions.

   3 man-days.

7. Credit to the City, all unused service man-days specified above, at the manufacturer's published field service rate.
8. Any additional time required of the factory trained service engineer to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the City.

G. Manufacturer of actuators must have at least five (5) operating installations with actuators of the type and size specified and in the same service as specified operating for not less than five (5) years.

H. Acceptable Manufacturers: Limitorque, Beck, Rotork, or EIM.

1.6 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 01610, Transportation and Handling, and as specified.

B. 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 at same time as pertaining equipment. Deliver to City after completion of work.
4. Pack spare hoses for protection against degradation due to sunlight and exposure to the elements.

C. Receiving:
1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, material and spare parts in accordance with manufacturer's written instructions.

PART 2 – PRODUCTS

2.1 ACTUATORS

A. Each actuator shall include electric motor, reduction gearing, reversing starters, thermal overloads, controls transformer, limit controls, non-intrusive local controls and hardwired status and control points as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
1. Provide actuators capable of setting of torque, turns, and configuration of indication contacts without the necessity to remove any electrical compartment covers.

Enclosure: Watertight to IP68, BASEEFA classification. Enclosure must be certified NEMA 6 by FM (Factory Mutual), for all units except those in classified areas.

2. Provide an internal watertight compartment to protect switches, contacts, motor and internal electronics from ingress of moisture and dust when the external terminal cover is removed.

3. Breathers and drains are not permitted, enclosure must be totally sealed.
4. Provide each actuator with a handwheel for manual operation. Provide a hammerblow device which permits motor to come up to speed before picking up load and unseating valve.

B. Motors:
1. Open/Close applications: Motors, Class F with 15-minute duty rating.
2. Modulating applications: Motors, Class H with a 30-minute duty rating.
3. Motor: Low inertia, high torque type to prevent over travel.

C. Provide internal clutch that cannot engage handwheel operating mechanism and motor-operating mechanism at the same time. Friction type declutching is not acceptable.
1. Provide handwheel with arrow and the word CLOSE or SHUT cast on handwheel to indicate turning direction to close.
2. Handwheel must not rotate during power operation.
3. Provide handwheel and low gear ratio combined to give maximum rate of movement possible with 80lb (36 kg) rim pull.

D. Reduction Unit:
1. Metal worm wheel and worm shaft type.
2. Provide an oil filled gear box. Grease lubrication is not acceptable.
3. Worm shaft to operate in ball or roller bearings and be machine cut, ground, and highly polished, hot rolled steel, hardness 50-60 Rockwell Scale C bronze worm wheel with large contact area. Provide mating surfaces of dissimilar metals to prevent galling. Cast metals or gears manufactured from non-metallic materials are not acceptable.
4. Worm and shafts: Heat-treated steel and accurately machined. Output or driving shaft to operate in bronze bearing or in ball or roller bearings.
5. Make provisions to take thrust in both directions.
6. Gearing to be oil lubricated at all times.
7. Gear case: Cast iron or aluminum depending on size of actuator offered, all thrust or torque bearing components shall be ductile iron.
8. Provide drive bushing as part of a detachable thrust base making for easy retrofit.

E. Fully wire electric motor operators at factory and furnish complete with terminal strips for external power and control connections. Wiring: copper with tropical grade PVC cover. Internal wiring to remain in a watertight compartment with external cover removed.

F. Provide manual or automatic control as indicated and specified.

G. Manual Control: Provide the following Control, Status, Alarm and Diagnostic capabilities locally, at the actuator:
   1. Control:
      a. Open/Stop/Close.
      b. Desired Valve Position Control 0-100%.
   2. Status:
      a. Motor Running Open Direction.
      b. Motor Running Close Direction.
      c. Fully Open.
      d. Fully Closed.
      e. Percentage Open 0-100% in 1% increments.
      f. Percentage Output Torque 0-100% in 1% increments.
   3. Alarms:
      a. Remote Control Communications Failure.
      b. Actuator Alarm.
      c. Valve Alarm.
      d. Battery Low Alarm.

H. Automatic Control: Provide REMOTE automatic control specified in Section 17100 and as indicated.

I. Each actuator shall be fitted with hard-wired contacts. Each Contact shall be rated at 5A, 250V, 30DC and provide the following features:
      a. REMOTE status.
      b. OPEN status.
      c. CLOSED status.
      d. OPEN command.
      e. CLOSE command.
      f. VALVE POSITION command (modulating actuator only).
      g. VALVE POSITION status (modulating actuator only).
      h. FAULT status.

J. Provide a back-up power source integral to the actuator to ensure that in the event of a main power supply loss or failure that the indication contacts still function on change of status.

K. Provide contacts and operating parts made of non-corrodible metal and suitable for a sea atmosphere and for contact with H2S.

L. Control Station:
   1. Provide for each actuator.
   2. Enclosure:
      a. NEMA 6 cast aluminum for all areas not classified.
      b. Provide red, green, and yellow indicating lights on operator. Green light on when valve, gate or equipment is completely closed, red light on when valve, gate or equipment is

completely opened, and yellow light when valve, gate or equipment is in mid travel.

c. Control circuits: 110VAC or 24VDC.

d. LOCAL/STOP/REMOTE switch: Padlockable in all positions.

e. OPEN/CLOSE switch.

M. Starters/transformers: Consists of two relay contactors, 3-pole, mechanically interlocked, reversing, with suitable arc suppressors.

1. Provide inverse time element overload relays.
2. Provide a control transformer capable of generating either 110VAC (220VAC) or 24VDC.
3. Provide electromechanical starter capable of OPEN/CLOSE sixty starts per hour. Size solid-state starter for modulating service at 1200 starts per hour.
4. Provide replaceable fuses to protect wiring, fuses must be locally available.
5. Provide automatic phase correction.

N. For actuators located higher than 5 feet (1.5 m) above the operating level or below finished floor level (in pits, etc.), provide a separate pushbutton enclosure. Mount on a pedestal, or on adjacent structure.

1. Provide actuator capable of accepting indication input from separate pushbutton station, that pushbutton station has been selected for remote control.
2. Provide each actuator with an unfused disconnect switch.
3. Enclosure Type: Refer to 2.1L.

O. For actuators located in chemical containment areas, provide extension stems to raise actuators above containment walk levels.

P. Limit Controls:

1. Type: Positive in action ensuring tight seating and full openings.
2. Position Setting Range: 2.5 to 100,000 turns, with resolution of 7.5 degrees of one actuator output revolution.
3. Provide mechanism designed to minimize drift or overtravel and to open or close valve, gate or equipment to fixed, predetermined limits of opening and closing travel.
4. Provide controls that disconnect driving mechanism from stem. Geared limit or torque type as required capable of predetermined limits of opening and closing travel. Potentiometers for position transmission are not acceptable.
5. Provide torque switches for both directions of travel.
    a. Sensing to be independent of voltage fluctuation. Mechanical torque springs are not acceptable.
    b. Provide torque protection to prevent repeated starting in the same direction.

c. The initial unseating hammer blow shall not cause overtorque.
d. Provide torque switch settings independent of OPEN/CLOSE position switches.

Q. Provide output shaft to accept rising stem for rising spindle valves and include roller and ball type thrust bearings.

R. Provide actuator sized to close valve, gate or equipment against required differential. Size actuator motor to seat and unseat valve gate or equipment and ensure torque switch trip at maximum valve torque when supply voltage is 10% below normal. Size motor to open or close valve, gate or equipment to satisfy the process dynamics.

S. All fasteners and hardware: Type 316 stainless steel.

T. Supply each actuator with a start-up kit comprising installation instructions, electrical wiring diagram, and sufficient spare cover screws and seals to make good any site losses during the commissioning.

2.2 SHOP TEST

A. Motor Test:
1. Give each motor a standard commercial test in the shop of the motor manufacturer, and submit certified copies of the test results to the Engineer for review prior to installation of the motors.

B. Actuator Testing:
1. Test performance of each actuator. Provide individual test certificates at no additional cost to the City simulate a typical valve, gate or equipment load and record the following parameters:
a. Current at maximum torque setting.
b. Torque at maximum torque setting.
c. Test voltage and frequency.
d. Flash test voltage.
e. Actuator output speed or operating time.
2. Test housing oil tightness, 30 psi for 2 minutes.
3. Insulation test on motor and control circuit.
4. In addition, record details of specification on the test certificate, such gear ratios for both manual and automatic drive, closing direction, wiring diagram code number, and when applicable remote transmitter resistance and interposing relay voltage.

C. In event that specified tests indicate that motor or actuator will not meet specifications, Engineer has the right to require complete witnessed tests for all motors and actuators at no additional cost to the City.
1. Repeat tests until specified results are obtained.

2. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to the City.

2.3 SHOP PAINTING

A. Paint Finish: Baked on polyester powder coating 70 microns thick and must have passed ASTM B117 35 degrees C Salt Spray Test for 1000 hours.

Provide materials for touch-up of all damaged or abraided surfaces due to installation.

B. Ferrous surfaces obviously not to be painted shall be given a shop-applied coat of grease or rust resistant coating.

2.4 SPARE PARTS

A. Provide spare parts that are identical to and interchangeable with parts installed.

B. Furnish and deliver the following spare parts for each actuator size:

Two fuses of each size.

C. Furnish and deliver the following spare parts for each size of actuator.

One set of all special tools required.

PART 3 – EXECUTION

3.1 INSTALLATION

Install items in accordance with manufacturer's printed instructions and as indicated and specified.

3.2 FIELD PERFORMANCE TESTS

A. After installation of equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service engineer, conduct running test for each actuator in presence of Engineer to determine its ability to operate without vibration or jamming and to operate at the speeds specified. During tests, observe and record, motor inputs. Promptly correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to the City, and repeat tests until specified results and results acceptable to the Engineer are obtained. Contractor to provide all labor, equipment, and materials necessary for conducting tests.

B. Make all adjustments necessary to place equipment in specified working order at time of above tests.

C. Remove and replace equipment at no additional cost to the City with equipment that will meet all requirements specified and indicated if unable to demonstrate to satisfaction of the Engineer that units will perform the service specified and indicated.

3.3 FIELD TOUCH-UP PAINTING

After installation and approved testing by the Engineer. Contractor shall apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

Table 1. Electric Motor Actuated Valve Schedule

Tag No.	Service	Location	Valve Type	Size (In)	Max. Flow (gpm)	Max. Oper. Press (Psig)	Oper. Type	Power Supply	Actuator Enclosure	Ends
FV-3431	Plant Water (W3)	Grit Settling and Sedimentation Basin 1	Butterfly	4	400	125	EQTT	480 VAC	NEMA 4X	Flanged
FV-3441	Plant Water (W3)	Grit Settling and Sedimentation Basin 2	Butterfly	4	400	125	EQTT	480 VAC	NEMA 4X	Flanged
FV-0701	NaOCl	Filter Building	Ball	2	10	10	EQTI	120 VAC	NEMA 4X	Solvent Welded
FV-0702	NaOCl	Filter Building	Ball	2	10	10	EQTI	120 VAC	NEMA 4X	Solvent Welded

END OF SECTION 15109

SECTION 15140
DUCTWORK SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 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.

1.2 SUBMITTALS

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

A. Manufacturer's certification.
B. Manufacturer's data.
C. Shop drawings.
D. Relevant Experience: Provide a list of such installations complete with installation description contact names, addresses, telephone numbers.
E. Operation and maintenance manuals.

1.3 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.

1.4 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.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 HANGER RODS

Steel Hanger Rods: Threaded both ends, threaded one end or continuous threaded.

2.2 INSERTS

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.

2.3 FLASHING

For Flashing see Section 07081, FLASHING AND SHEET METAL.

2.4 EQUIPMENT CURBS

Fabricated curbs shall be provided by equipment manufacturer supplying the associated equipment.

2.5 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.

2.6 FABRICATION

Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

2.7 FINISH

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

3.1 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.

3.2 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.

3.3 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.

3.4 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 15250
MECHANICAL INSULATION

PART 1 - GENERAL

1.1 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. The types of mechanical insulation specified in this Section include the following:
   1. Piping System Insulation - Flexible Unicellular.
   2. Ductwork System Insulation - Fiberglass.

D. Related Work Specified Elsewhere:
   1. Section 15050, Basic Mechanical Materials and Methods.
   2. Section 15060, Piping and Appurtenances.
   3. Section 15891, Ductwork.
   4. Section 15910, Ductwork Accessories.

1.2 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.

1.3 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.

1.4 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

2.1 GENERAL

A. Flexible unicellular piping insulation: ASTM C1 534, Type I.

B. Rigid fiberglass ductwork insulation: ASTM C 612, Class 1.

C. Ductwork Insulation Accessories:
Provide staple, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

D. Ductwork Insulation Compounds:
Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

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.

3.2 HVAC PIPING SYSTEM INSULATION

A. Insulate sub-freezing HVAC piping systems with flexible unicellular, 1" thick for pipe sizes up to 1-1/2" above ground.

B. Insulate sub-freezing HVAC piping systems with cellular glass, 1-1/2" thick for pipes underground.

C. Insulate the following sub-freezing HVAC piping systems:
Refrigerant suction lines between evaporators and compressors.

3.3 DUCTWORK SYSTEM INSULATION

A. Do not insulate fibrous glass ductwork, or lined ductwork.

B. Insulate the following cold ductwork:
1. Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
2. HVAC supply ductwork between fan discharge or HVAC unit discharge and room terminal outlet.
3. Insulate neck and bells of supply diffusers.
4. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet; except omit insulation on return ductwork located in return air ceiling plenums.
5. HVAC plenums and unit housings not pre-insulated at factory or lined.
6. HVAC exterior supply ductwork with weatherproof metal jacket.

C. Insulate each ductwork system specified above with one of the following types and thicknesses of insulation:
1. Rigid fiberglass, 1-1/2" thick, increase thickness to 2" in machine, fan and equipment rooms with vapor barrier.
2. Flexible fiberglass, 1-1/2" thick, application limited to concealed locations with vapor barrier.

3.4 EQUIPMENT INSULATION

Insulate the following cold equipment with fiberglass insulation, 2" thick for surfaces 35° F and 3" thick for surfaces 35° F and lower:
Drip pans under chilled equipment.

3.5 INSTALLATION OF PIPING INSULATION

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.

A. 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.

B. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

C. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.

E. 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.

F. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.

G. 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.

3.6 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.

3.7 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

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SECTION 15400
PLUMBING

PART 1 - GENERAL

1.1 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 02050, Demolition
3. Section 02200, Earthwork
4. Section 03200, Concrete Reinforcement and Dowelling
5. Section 03250, Concrete Joints
6. Section 04810, Masonry
7. Section 09900, Painting
8. Section 15050, Basic Mechanical Materials and Methods
9. Section 15060, Piping and Appurtenances
10. Section 16050: Basic Electrical Materials and Methods

1.2 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.

1.3 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. 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.

1.4 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.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS:

A. Domestic water:

1. Maximum 2-1/2 in.: 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:

Drain, waste and vent pipe shall be constructed of PVC or ductile iron pipe where shown on the Drawings in accordance with Section 15250.

2.2 INSULATION:

A. Insulation shall be in accordance with Section 15250.

B. Insulate hot and cold water piping systems in the Sludge Dewatering Building from the inlet to the backflow preventer, and from the backflow preventer to all cold and hot water plumbing fixtures/equipment connections.

C. Insulate cold water piping systems in the Solids Processing Pump Station from the inlet to the backflow preventer, and from the backflow preventer to all cold water plumbing fixtures/equipment connections. Insulate all plant water piping in the Solids Processing Pump Station.

2.3 PLUMBING - FIXTURES AND ACCESSORIES:

A. Manufacturers listed in schedule; acceptable equivalent products considered.
B. Provide fixture with valves, vacuum breakers, air gaps, faucets, flush valves, drains, traps, wall plates and escutcheons; stamped index on faucet handles.
C. Exposed metal parts: heavy chrome-plated brass, polished surface.
D. Pipe connections: minimum size listed in fixture-connection schedule.
E. Schedule of Plumbing Fixtures:

SCHEDULE OF FIXTURES

Fixture and Accessories	Manufacturer and Catalog No.		
1. a. Service Sink b. Guard c. Faucet d. P-Trap	 American Standard 7695.008 Integral to unit American Standard 8340.243 (Rough Chrome) American Standard 7798.030	Kohler	Eljer

SCHEDULE OF CONNECTION SIZES

Fixture	Waste (inches)	Supply (inches)
1. Service Sink	3	1/2

2.5 DRAINS

A. Floor drains shall be coated cast iron, two piece body with double drainage flange Josam 32120 Series or Equal conforming to the requirements of ASTM-C564. Floor drains shall include non-puncturing flashing collar, weepholes, bottom outlet inside caulk connection and removable shallow sediment bucket.

B. Roof drains shall be coated cast iron, large polypropylene locking dome Josam 23500 Series or equal. Roof drains shall include non-puncturing clamp ring with integral gravel stop, large sump with wide roof flange and bottom outlet inside caulk connection.

C. Floor sinks shall be rectangular cast iron Josam 49603 Series or Equal. Floor sinks shall be acid-resisting interior, double drainage flange with weepholes, bottom outlet, aluminum internal dome strainer, NiKaloy rim and NiKaloy grate.

2.6 ELECTRIC WATER HEATER

A. Manufacturer:

1. Lochinvar Model JRC010DS.

2. Bradford White.
3. State.

B. Construction:

1. UL approved and electric heating elements shall be UL approved and conformed to NEMA standards.
2. Tank: Glass-lined, welded steel tank, vertical, storage, thermally insulated with polyurethane closed-cell foam, encased in corrosion-resistant steel jacket with baked on enamel finish.
3. Immersion Elements: Zinc-coated, copper sheath design.
4. Controls: Automatic water thermostat with externally adjustable temperature range from 120 to 160 degrees F, enclosed controls and electrical junction.
5. Accessories: Brass water connections and dip tube, brass drain valve, high density magnesium anode, and ASME rated temperature and pressure relief valve.
6. Electrical: 120/1/60, 1650 Watt element.

C. Capacity: 10 gallons.

2.7 PAINTING

Painting shall be in accordance with Section 09900, Painting.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION

A. General:

1. Furnish and install all plumbing fixtures and equipment, water, vent, sanitary drainage and associated piping.
2. Install equipment to grades and elevations at locations indicated on Drawings.

3. Make piping connections to equipment preventing excessive strain on equipment; install flexible connections where required.

B. Piping and Insulation:

Install in accordance with the requirements of Section 15250.

C. Fixtures and Accessories:

1. Install where indicated.

2. Install toilet accessories in locations acceptable to Engineer.

3. Install escutcheons at wall, ceiling and floor penetrations.

END OF SECTION

SECTION 15650
SPLIT SYSTEM FAN COIL UNITS

PART 1 - GENERAL

1.1 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 split system fan coil units/condensing units and controls. 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.

1.2 SUBMITTALS

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

A. Manufacturer's Certification.

B. Manufacturer's data.

C. Operation and maintenance manuals.

D. Complete wiring and control diagrams.

1.3 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. 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. AGMA, American Gear Manufacturer's Association.
8. AFBMA, Anti-Friction Bearing Manufacturer's Association.
9. NFPA, National Fire Protection Association.
10. ARI Air-Conditioning and Refrigeration Institute.

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 that have a demonstrated record of successful operation. Provide a list of such installations complete with installation description contact names, addresses, telephone numbers. This reference list shall be submitted with the shop drawings.

1.4 QUALITY STANDARDS

A. The fan coil units/condensing units 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 electrical unit heater manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:

1. Trane, Model BCHD & Model 4TTB3.
2. Carrier.
3. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 FAN COIL UNITS

A. General: Provide and install fan coil units as described herein and as indicated on the Drawings. The units shall utilize split system refrigerant cooling and designed for indoor suspended installations. The unit shall be specifically designed for space control

applications. The unit shall include a fan, DX evaporator coil, and filter sections.

B. Cabinet: Unit shall be constructed of heavy-gauge galvanized steel, insulated with one inch thick, 1-1/2 lb density fiberglass fire resistant and odorless material to provide thermal and acoustical insulation. Fan housing sides shall be directly attached to the fan coil unit top and bottom panels for strengthening the entire unit assembly. Coil, fan and motor access panels on both sides of the fan coil unit shall allow for easy removal of the internal coil and drain pan as well as access to the fan and motor.

C. Fan: Unit shall be equipped with a single fan, DWDI (double width double inlet) forward curved centrifugal blower type, direct drive, directly mounted to the motor shaft. Fans shall be dynamically balanced.

D. Direct Expansion (DX) Coils: DX coils shall be suitable for use with refrigerant R-410A. Coils shall be constructed of 3/8" OD x 0.014" W round seamless copper tubes expanded into full fin collars for permanent fin-tube bond. Highly efficient aluminum fins shall be mechanically bonded to stainless copper tubes with 12 fins per inch spacing. Coil casing shall be constructed of 16-gauge galvanized steel with foam sealing between the casing top and bottom channels. Coils shall have round, seamless, copper pipe liquid lines and suction headers with male sweat connections. Suction headers shall bottom connections to aid drainage of any oil that may collect in the coil. Liquid line and suction connections shall be outside the unit casing to facilitate field piping. Coils shall be tested at 715 psig and leak tested at 650 psig air under water. Coils shall be dehydrated and sealed with dry air charge. Maximum standard operating conditions are 650 psig at 127 degrees F with R-410A. Coils shall be rated and tested in accordance with ARI Standard 410.

E. Drain Pan: The drain pan shall be noncorrosive and constructed of polymer and be double-sloped to allow condensate drainage. Drain pan shall be mounted below coils to allow the drain pan to be fully inspected and cleaned and be able to be removed for cleaning. Drain pan connections shall be unthreaded 3/4 inch NPT schedule 40 PVC for solvent bonding. Main connection shall be at the lowest point of the drain pan with an auxiliary drain pan connection provided on the same side as the main.

F. Filter: Filter shall be two inch MERV 8 installed in a standard flat filter rack that is sized for less than 500 feet per minute nominal airflow.

G. Control Section: Unit shall be equipped with a disconnect switch, fused transformer, contactors, and terminal strip for control interface. The control box shall contain a line voltage to 24 volt transformer. Provide a 24 volt wall mounted cooling thermostat for unit control.

2.2 CONDENSING UNIT

A. General: Condensing unit shall factory fully charged for matched indoor section and up to 15 feet of refrigerant piping.

B. Casing: Unit casing shall be constructed of heavy gauge, galvanized steel and painted with weather resistant powder paint. Corrosion and weatherproof CMBP-G30 base.

C. Refrigerant Controls: Refrigeration system controls shall include condenser fan and compressor contactor, high and low pressure controls, and standard liquid line dryer. Provide for low ambient cooling down to 30 degrees F.

D. Compressor: Scroll type compressor with total dipped hermetic motor, with centrifugal oil pump. Compressor shall be resiliently mounted integral with condenser, with positive lubrication, compressor motor starter, crankcase heater, high pressure control, motor overload protection, anti-cycle timer to prevent restart for at least 5 minutes after start-up, and service valves. Provide time delay control to prevent short cycling.

E. Condenser Coil: Outdoor coil shall be constructed of copper tube and aluminum fins with direct drive axial propeller fan and galvanized fan guard. Coil shall provide low airflow resistance and efficient heat transfer. The coil shall be protected on all four sides by louvered panels.

F. Refrigerant Accessories: Provide liquid line filter and sight glass, suction filter dryer, high pressure switch (manual reset), low pressure switch (automatic reset), service valves, and gage ports, thermometer well (in liquid line). Provide thermostatic expansion valves. Provide refrigerant lines, factory-cleaned, dried, pressurized and sealed, with insulated suction line.

PART 3 - EXECUTION:

3.1 INSTALLATION

The equipment shall be installed in strict conformance with the approved shop drawings and manufacturer's installation instructions.

3.2 EQUIPMENT TESTING

After completion of the work, test and regulate heating coils, and unit heaters, to conform to conditions indicated on the Drawings. Contractor shall adjust apparatus for securing proper volumes and conditions.

+++ END OF SECTION 15650 +++

SECTION 15700
ELECTRICAL UNIT HEATERS

PART 1 - GENERAL

1.1 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 electrical unit heaters and controls. 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.

1.2 SUBMITTALS

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

A. Manufacturer's Certification.

B. Manufacturer's data.

C. Operation and maintenance manuals.

D. Complete wiring and control diagrams.

1.3 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. 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. AGMA, American Gear Manufacturer's Association.
8. AFBMA, Anti-Friction Bearing Manufacturer's Association.
9. 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 that have a demonstrated record of successful operation. Provide a list of such installations complete with installation description contact names, addresses, telephone numbers. This reference list shall be submitted with the shop drawings.

1.4 QUALITY STANDARDS

A. The electrical unit heaters 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 electrical unit heater manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:

1. Explosion Proof Unit Heaters-Chromalox, Model CUH-Series.
2. Unit Heaters-Chromalox, Model LUH Series.
3. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 ELECTRICAL UNIT HEATER

Provide and install electrical unit heater as described herein and as indicated on the Drawings.

A. Unit heater shall be horizontal and wall mounted.

B. Furnish electrical heater with mounting brackets.

C. Unit heater heat bank shall consist of patented Chromalox spiral metal sheath fintube electric heating elements with built-in overheat protection.

D. Furnish heavy duty magnetic control contactor.

E. Furnish Chromalox WR-80 thermostat or equal.

2.2 CONTROLS

Unit heaters shall be energized by their respective 2-stage thermostats set at 70^0. The unit heater shall de-energize when room temperature is 70^0 F.

PART 3 - EXECUTION:

3.1 INSTALLATION

The equipment shall be installed in strict conformance with the approved shop drawings and manufacturer's installation instructions.

3.2 EQUIPMENT TESTING

After completion of the work, test and regulate heating coils, and unit heaters, to conform to conditions indicated on the Drawings. Contractor shall adjust apparatus for securing proper volumes and conditions.

+++ END OF SECTION 15700 +++

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SECTION 15750
ELECTRICAL MAKE-UP AIR HANDLING UNITS

PART 1 - GENERAL

1.1 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 electrical make-up air handling units and controls. 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.

1.2 SUBMITTALS

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

A. Manufacturer's Certification.

B. Manufacturer's data.

C. Operation and maintenance manuals.

D. Complete wiring and control diagrams.

1.3 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. 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. AGMA, American Gear Manufacturer's Association.
8. AFBMA, Anti-Friction Bearing Manufacturer's Association.
9. 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 that have a demonstrated record of successful operation. Provide a list of such installations complete with installation description contact names, addresses, telephone numbers. This reference list shall be submitted with the shop drawings.

1.4 QUALITY STANDARDS

A. The electrical unit heaters 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 electrical unit heater manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:

1. Reznor, Model REH.
2. Brasch, Model Series M.
3. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 ELECTRICAL MAKE-UP AIR HANDLING UNITS

Provide and install packaged outdoor electrical make-up air handling units as described herein and as indicated on the Drawings. The units shall be utilizing electric heating elements designed for rooftop or outdoor slab. The unit shall be specifically design for make-up air and space control applications. The unit shall be modular with a fan, electrical resistance heating, and filter

sections.

2.2 POWER

All units shall be equipped for use with 460/3 unit supply voltage. The unit shall have single power connection for 3 phase or 1 phase wiring with factory installed distribution blocks. The unit shall have unit mounted, non-fusible, NEMA 4X, lockable disconnect switch. The control voltage wiring shall be class 2, 120Vac. Unit shall have over/under voltage or phase loss protection; factory supplied, field powered convenience outlet ground-fault circuit interrupter.

2.3 FAN AND AIR CONTROL SECTION

The base unit fan shall include an adjustable belt-driven centrifugal fan with totally enclosed motor. The motor shall have rubber vibration isolated with contactor and motor starter. Fan shall have air proving switch inter-locked with electric resistant coil to prevent heat operation when the fan is not operational. The fan shall use solid-belt. The fan assembly shall be factory set to specified CFM at the given static pressure. The fan assembly shall have adjustable sheave for airflow adjustment. The fan assembly shall be shipped with spare belts. Unit shall have 2" MERV 8 pleated filters.

2.4 ELECTRIC HEAT SECTION

Unit shall include blow through electric resistance heating section using open element with insulated ceramic bushing, fuses, contactors, auto reset high temperature limit switch and other necessary safety devices. Provide capacity sizes and staged/modulating control as shown on the schedule. The furnace shall be equipped with all required safety elements. Unit shall have a SCR electronic modulation heating for MUA applications with space temperature reset.

2.5 CONTROLS SECTION

Unit heaters shall be energized by their respective 2-stage thermostats set at 48^0. The unit heater shall de-energize when room temperature is 50^0 F. Unit shall be equipped with factory installed contactors, relays, sensor, switches to perform analog discharge air control. The unit shall control fan and heating functions with discharge thermostat control. The unit shall have label terminal blocks and unit mounted ladder logic wiring diagram.

2.6 CABINET SECTION

The double wall insulated fan section shall be supplied with horizontal supply air inlet opening with duct flanges. The unit shall have outside air hood with permanent filters designed for 100% unit air flow from outside with zero water/snow entrainment. The hood shall meet ASHRAE Standard 62.1 entrainment intent. The packaged system shall have a pre-coat RAL 1001 white paint finish. Finish shall be a minimum 80 gloss on G30 galvanized steel. Cabinet shall be arranged for slab mount. Control, heater, and fan service compartment doors shall be hinged. Fan door hardware shall be heavy duty stainless. Control and heater door hardware shall have heavy duty external hardware. Cabinet shall have through-the-base electrical supply knockout.

2.7 OPTIONAL ACCESSORIES

The following features will be factory installed: duct flanges; discharge temperature low limit; and relays.

PART 3 - EXECUTION:

3.1 INSTALLATION

The equipment shall be installed in strict conformance with the approved shop drawings and manufacturer's installation instructions.

3.2 EQUIPMENT TESTING

After completion of the work, test and regulate heating coils, and unit heaters, to conform to conditions indicated on the Drawings. Contractor shall adjust apparatus for securing proper volumes and conditions.

+++ END OF SECTION 15750 +++

SECTION 15870
POWER VENTILATORS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of power ventilator type centrifugal fans. 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 15950, HVAC Controls.
   3. Section 15891, Ductwork.
   4. Section 15990, Testing, Adjusting and Balancing.
   5. Division 16, Electrical.

1.2 SUBMITTALS

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

A. Certified fan performance curves with system operating conditions indicated.

B. Certified fan sound power ratings.

C. Motor ratings and electrical characteristics plus motor and fan accessories.

D. Materials gages and finishes, including color charts.

E. Dampers, including housings, linkages and operators.

F. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components and location and size of field connections.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of power ventilator centrifugal type fans, of types and in similar service for not less than 5 years.

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. NEC, National Electric Code
   6. NFPA, National Fire Protection Association.
   7. FM, Factory Mutual Engineering Corporation.
   8. UL, Underwriters Laboratories, Inc.
   9. AMCA, Air Movement and Control Association.

1.4 QUALITY STANDARDS

Manufacturer's offering products that comply with these specifications include:

A. Hartzell Fan, Inc.

B. ILG Industries, Inc.

C. Peerless-Winsmith, Inc.

D. Stanley Industrial Corp.

E. Cook (Loren) Co.

F. Essick Air Products

G. Or equal.

1.5 STORAGE AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver fan units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.6 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide fans that are factory fabricated and assembled, factory tested and factory finished with indicted capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

C. Fan Shaft: Turned, ground and polished steel designed to operate at no more that 70 percent of the first critical speed at the top of the speed range of the fan's class.

D. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation. Belts shall be oil resistant, non-sparking and non-static. Service factor shall be 1.4.

E. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

F. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

G. Shaft Bearings: Provide type indicated, having a median Rated Life of 200,000 in accordance with AFBMA Standards.

H. The following factory finishes are required:
   1. Sheet metal parts shall be prime coated prior to final assembly.
   2. Exterior surfaces shall be baked-enamel finish coat after assembly.

2.2 WALL EXHAUSTER

Belt-driven or direct-drive wall exhauster as indicated consisting of centrifugal fan, housing, resilient mounted motor, 1/2 inch mesh, 16 gage aluminum birdscreen, drive and accessories.

A. Housing shall be aluminum.

B. Backward inclined all aluminum wheel.

C. Mounting flange with keyslots and template.

D. Drive assembly shall be direct-drive or belt-driven as indicated.

E. Two piece top cap with stainless steel quick release latches.

F. Belt drive assembly shall be resiliently mounted to the housing with the following features:
   1. Pulleys shall be cast-iron or steel, dynamically balanced, bored to fit shafts and keyed, variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position, fan shaft self-aligning, pre-lubricated ball bearings.
   2. Shaft bearings shall be permanently lubricated, permanently sealed, self-aligning ball bearings.
   3. Fan shaft shall be turned, ground and polished steel drive shaft keyed to wheel hub.
   4. Motor and drive assembly shall be resiliently mounted to the housing.

G. Accessories are required as follows:
   1. Aluminum birdscreens.
   2. Aluminum gravity backdraft dampers, multiple blade construction, felt edged with nylon bearings, shall be provided with each wall fan.
   3. Square wall grille for covering interior wall openings.

2.3 SPARE PARTS

Furnish one additional complete set of belts for each belt-driven fan.

PART 3 - EXECUTION

3.1 EXAMINATION

Examine areas and conditions with Installer present, for compliance with requirements for installation tolerances, housekeeping pads and other conditions affecting performance of fans. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION

A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below and using vibration control devices where shown on Drawings. Arrange installation of units to provide access space around air-handling units for service and maintenance.

B. Suspend units from structural elements using threaded steel rods and vibration isolation springs.

3.3 CONNECTIONS

A. Duct installation and connections shall be in accordance with Sections 15981 and 15910.

Make final duct connections with flexible connections.

B. Electrical connections shall be furnished under Division 16, Electrical.
   1. Temperature control wiring and interlock wiring shall be in accordance with Section 15950 HVAC Controls.
   2. Connect unit components to ground in accordance with the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:
   1. Inspect the field assembly of components and installation of fans including ductwork and electrical connections.
   2. Prepare a written report on findings and recommended corrective actions.

B. Adjusting, Cleaning and Protecting: Adjust damper linkages for proper damper operation. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.5 COMMISSIONING

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:
   1. Remove shipping blocking and bracing.
   2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork and electrical are complete. Verify proper thermal overload protection is installed in motors, starters and disconnects.
   3. Perform cleaning and adjusting specified in paragraph 3.04.
   4. Disconnect fan drive form motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts and install belt guards.
   5. Lubricate bearing, pulley, belts and other moving parts with factory-recommended lubricants.
   6. Verify manual and automatic volume control dampers in connected ductwork systems are in the full-open position.
   7. Disable automatic temperature control operators.

B. Starting Procedures for Fans:
   1. Energize motor, verify proper operation of motor, drive system and fan wheel. Adjust fan to indicated RPM.
   2. Replace fan and motor pulleys as required to achieve design conditions.
   3. Measure and record motor electrical values for voltage and amperage.
   4. Shut unit down and reconnect automatic temperature control operators.

C. Testing, adjusting and balancing shall be in accordance with Section 15990 for air-handling system.

END OF SECTION

SECTION 15891
DUCTWORK

PART 1 - GENERAL

1.1 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 07900, Caulking and Sealants.
   2. Section 08110, Steel Doors and Frames.
   3. Section 15050, Basic Mechanical Materials and Methods.
   4. Section 15250, Mechanical Insulation.
   5. Section 15910, Ductwork Accessories.
   6. Section 15990, Testing, Adjusting and Balancing of HVAC Systems.

D. Definitions:
   Sealing Requirements: For the purposes of duct system sealing requirements specified in this Section the following definitions apply:
   1. 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.
   2. 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.

1.2 SUBMITTALS

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

A. Product data including details of construction relative to material, dimensions of individual components, profiles, and finishes for the following items:
    1. Duct liner.
    2. Sealing materials.
    3. Fire-stopping materials.

B. 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:
    1. Fabrication, assembly and installation details for metal and glass fiber ducts, including plans, elevations, section, details of components and attachments to other Work.
    2. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled.
    3. Fittings.
    4. Reinforcing details and spacing.
    5. Seam and joint construction details.
    6. Penetrations through fire-rated and other partitions.
    7. Terminal unit, coil and humidifier installations.
    8. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.

C. Coordination drawings for ductwork installation shall show the following:
    1. Coordination with ceiling suspension members.
    2. Spatial coordination with other systems installed in the same space with the duct systems.
    3. Coordination of ceiling and wall mounted access doors and panels required to provide access to dampers and other operating devices.
    4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Record drawings including duct systems routing, fittings, details, reinforcing, support and installed accessories and devices.

E. Maintenance data for volume control devices, fire dampers and smoke dampers.

1.3 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:

A. ASTM, American Society for Testing Materials.

B. ASME, American Society of Mechanical Engineers.

C. OSHA, Occupational Safety and Health Act.

D. ANSI, American National Standards Institute.

E. NFPA, National Fire Protection Association.

F. UL, Underwriters Laboratories, Inc.

G. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers.

H. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association.

I. TIMA, Thermal Insulation Manufacturer's Association.

J. ICBO, International Conference of Building Officials.

1.4 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.

1.5 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.

1.6 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 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.

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.

2.2 DUCT LINER FOR METAL DUCT

Metal duct liners shall comply with NFPA Standard 90A and TIMA Standard AHC-101.

A. Materials: ASTM C 1071, Type II, with coated surface exposed to air stream to prevent erosion of glass fibers.

B. Thickness: 1- inch.

C. Density: 3 pounds.

D. Thermal Performance: K-Factor shall be equal to 0.28 or better, at a mean temperature of 75ºF.

E. 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.

F. Liner Adhesive: Comply with NFPA Standard 90A and ASTM C 916.

G. 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.

1. Fastener pin length shall be as required for thickness of insulation and without projecting more that 1/8-inch into the air stream.
2. Adhesive for attachment of mechanical fasteners shall comply with Fire Hazard Classification of duct liner system.

2.3 SEALING MATERIALS

Joint and Seam Sealants: The term sealant used in this Section is not limited to material of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

A. Joint and Seam Tape: 2-inch wide, glass-fiber-fabric reinforced.

B. Joint and Seam Sealant: One-part, non sag, solvent-release-curing, polymerized butyl sealant; formulated with a minimum of 75 percent solids.

C. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

D. 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.

2.4 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 form ductwork.

2.5 RECTANGULAR DUCT FABRICATION

A. Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, 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.

2.6 RECTANGULAR DUCT FITTINGS

Fabricate elbows, transitions, offsets, branch connections and other duct construction in accordance with SMACNA HVAC Duct Construction Standard.

2.7 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.

2.8 ROUND AND FLAT OVAL DUCT FABRICATION

A. Basic round diameter as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given size of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet. Round Ducts: 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 75ºF 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. For flat oval ducts, the diameter indicated in the table below is the basic round diameter.

2.9 ROUND AND FLAT OVAL SUPPLY AND EXHAUST FITTINGS FABRICATION

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 45º and 90º 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 75ºF 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.

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 nominal single-wall size.

D. 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

3.1 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.

3.2 SEAM AND JOINT SEALANT

Seal duct seams and joints as follows:

A. Pressure Classifications Greater than 3 Inches Water Gage: All transverse joints, longitudinal seams and duct penetrations.

B. Pressure Classification 2 and 3 Inches Water Gage: All transverse joints and longitudinal seams.

C. Pressure Classification Less than 2 Inches Water Gage: Transverse joints only.

D. Seal externally insulated ducts prior to insulation installation.

3.3 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.

3.4 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.

3.5 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

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SECTION 15910
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 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. Turning vanes.
   3. Duct hardware.
   4. Duct access doors.
   5. Flexible connections.
   6. Supply registers.
   7. Exhaust grilles.

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.

1.2 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.

1.3 QUALITY ASSURANCE

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:

A. SMACNA Compliance. Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".

B. Industry Standards. Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

C. UL Compliance. Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".

D. NFPA Compliance. Comply with applicable provisions of NFPA 90A "Air conditioning and Ventilating Systems", pertaining to installation of ductwork accessories.

E. ADC Compliance. Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

F. ADC Seal. Provide air outlets and inlets bearing ADC Certified Rating Seal.

G. AMCA Compliance. Test and rate louvers in accordance with AMCA 500 Test Method for louvers, Dampers and Shutters."

H. AMCA Seal. Provide louvers bearing AMCA Certified Rating Seal.

1.4 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. 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.

3. Duct Hardware:
   a. Ventfabrics, Inc.
   b. Young Regulator Co.
   c. Or equal.

4. 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.

5. Flexible Connectors:
   a. American/Elgen Co.; Energy Div.
   b. Duro Dyne Corp.
   c. Flexaust (The) Co.
   d. Ventfabrics, Inc.
   e. Or equal.

6. Supply Registers:
   a. Titus.
   b. Anemostat.
   c. Carnes.
   d. Or equal.

7. Exhaust Grilles:
   a. Titus.
   b. Anemostat.
   c. Carnes.
   d. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 DAMPERS

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.

2.2 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.

2.3 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.

2.4 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.

2.5 FLEXIBLE CONNECTIONS

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.

2.6 SUPPLY REGISTERS

A. General. Provide supply registers where shown in ductwork.

B. Construction. Streamlined and individually adjustable blades to discharge air along face of grille with two-way deflection constructed of aluminum extrusions with clear lacquer finish. 1-1/4 inch margin concealed mounting and gasket. Provide supply registers with integral, gang-operated, opposed blade type with removable key operator, operable from the face.

2.7 EXHAUST GRILLES

A. General. Provide exhaust grilles where shown in ductwork.

B. Construction. Eggcrate type with fixed grilles 1/2 by 1/2 by1/2 inches constructed of aluminum extrusions with clear lacquer finish. 1-1/4 inch margin concealed mounting and gasket. Provide exhaust grilles with integral, gang-operated, opposed blade type with

removable key operator, operable from the face.

PART 3 - EXECUTION

3.1 INSPECTION

Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 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.

3.3 SPARE PARTS

Furnish to Engineer, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

3.4 FIELD QUALITY CONTROL

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.

3.5 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 +++

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SECTION 15950
HVAC CONTROLS

PART 1 - GENERAL

1.1 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:

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 specified under Section 11400.

1.2 SUBMITTALS.

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

A. 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.

B. Schematic flow diagram of system showing fans, dampers, and control devices.

C. Label each control device with setting or adjustable range of control.

D. Control interlock wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

E. Details of faces of control panels, including controls, instruments, and labeling.

F. Written description of sequence of operation.

G. Wiring diagrams.

H. Operation and maintenance manuals.

1.3 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.

1.4 QUALITY STANDARDS

Manufacturer. Subject to compliance with requirements, provide electric control systems of one of the following.

A. Barber-Colman Co.

B. Honeywell, Inc.

C. Johnson Controls, Inc.

D. Landis & Gyr Powers, Inc.

E. Robertshaw Controls Co.

F. Or equal.

1.5 DELIVERY, STORAGE, AND HANDLING

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

2.1 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. Exhaust Fan Thermostats. Provide exhaust fan thermostats with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated.

1. Honeywell Model T631C.
2. Provide thermostats with spiral bimetallic thermometers.
3. Exhaust Fan Thermostats. Provide line voltage type rated for 10 amps at 115 VAC and pilot duty at 115 volts, single phase, with metal enclosure and minimum range of 70 to 90 degrees F. 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.

C. Duct Smoke Detectors. 24 volt, self-contained, duct-mounted with contacts for both fan control and annunciation of a remote alarm. Provide unit with an ionization type detector assembly, removable filters, auxiliary contacts, and remote test station with manual reset.

D. 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.

E. Flow Switches: Adjustable Air Flow Switch capable of detecting a wide range of air velocities with minimal user calibration. Stainless steel vane, galvanized steel base, and ABS enclosure. Capable of sensing airflow velocities ranging from 200-1800 FPM. Operating temperatures shall range between -40°F and 180°F.

E. 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

F. 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

3.1 INSPECTION

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.

3.2 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.

3.3 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.

3.4 CLOSEOUT PROCEDURES

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.

3.5 SEQUENCE OF OPERATION

A. Ventilation Systems (EA WQCF-Sludge Dewatering Building).

1. AHU-1/EF-1 (Sludge Dewatering Room): Heating and ventilation for the Sludge Dewatering Room shall be by a make-up air handling unit AHU-1 with electric heating and wall mounted centrifugal exhaust fan EF-1. EF-1 shall be interlocked with AHU-1. The system shall run continuously and provide 6 air changes per hour of airflow to the room. This is so that the room shall have an NEC area classification rating of unclassified. The supply airflow shall be larger than the exhaust airflow in order to provide positive pressure to the space.
2. AHU-1 shall be controlled by an HAND-OFF-AUTO switch, control panel, and thermostats. AHU-1 shall run continuously and shall supply 100% of outside air to the space and be interlocked with EF-1. AHU-1 through SCR control shall modulate the electric resistance heating coil to satisfy supply air duct thermostat setting. A thermostat shall override the supply air duct thermostat and shall cause the unit to go to full heat when the room temperature falls below the override room thermostat setpoint of 55 degrees F.
3. Safety and airflow devices shall consist of the following. A duct mounted freeze protection thermostat located downstream of the unit in the supply ductwork shall deactivate AHU-1 whenever it senses a temperature below 40 degrees F. A signal alarm light “AHU-1 FREEZE” on the AHU-1 control panel. A duct mounted smoke detector SD located in the supply ductwork downstream of the unit shall deactivate AHU-1 whenever smoke is detected and signal alarm light “SMOKE” on AHU-1 control panel. Differential pressure switch PS shall signal indicator light “FAN ON” on AHU-1 control panel whenever fan is in operation. Differential pressure switch

PS shall signal indicator light "DIRTY FILTER" on AHU-1 control panel upon sensing a clogged filter on AHU-1. A flow switch shall be installed in the ductwork to sense continuous airflow where shown on the drawings. Upon sensing low flow, a signal shall be sent to the alarm system to notify that ventilation airflow is insufficient.

B. Exhaust Fans (EA WQCF-Sludge Dewatering Building).

Exhaust fan EF-2 (Electrical Room) shall be controlled by a HAND-OFF-AUTO switch. In the HAND position, the exhaust fan motor is activated. In AUTO position, a single temperature, wall-mounted thermostat shall cycle the fan motor. Motorized intake louver L-1 that provides make-up air for the exhaust fan, open the louver whenever the exhaust fan is activated. A flow switch shall be installed in the ductwork to sense continuous airflow where shown on the drawings. Upon sensing low flow, a signal shall be sent to the alarm system to notify that ventilation airflow is insufficient.

C. Electric Unit Heaters.

Unit heater fans and heating elements shall ACTIVATE upon space temperature falling to 55^0 F or below.

D. Sludge Pumping Station Electrical Room (EA WQCF).

Cool the Electrical Room by a split system consisting of an indoor fan coil unit FC-1 and outdoor condensing unit CU-1. Control the system by a single stage cool, hard-wired, wall mounted thermostat. Energize FC-1 fan and CU-1 whenever the thermostat calls for cooling. De-energize the cooling and fan when thermostat has reached set-point.

E. Solids Processing Pump Station (EA WQCF).

1. AHU-1/EF-1: Heating and ventilation for the Solids Processing Pump Station shall be by a make-up air handling unit AHU-1 with electric heating and wall mounted centrifugal exhaust fan EF-1. EF-1 shall be interlocked with AHU-1. The system shall run continuously and provide 6 air changes per hour of airflow to the room. This is so that the room shall have an NEC area classification rating of unclassified. The supply airflow shall be larger than the exhaust airflow in order to provide positive pressure to the space.
2. AHU-1 shall be controlled by a HAND-OFF-AUTO switch, control panel, and thermostats. AHU-1 shall run continuously and shall supply 100% of outside air to the space and be interlocked with EF-1. AHU-1 through SCR control shall modulate the electric resistance heating coil to satisfy supply air duct thermostat setting. A thermostat shall override the supply air duct thermostat and shall cause the unit to go to full heat when the room temperature falls below the override room thermostat setpoint of 55 degrees F.
3. Safety and airflow devices shall consist of the following. A duct mounted freeze protection thermostat located downstream of the unit in the supply ductwork shall

deactivate AHU-1 whenever it senses a temperature below 40 degrees F. A signal alarm light "AHU-1 FREEZE" on the AHU-1 control panel. A duct mounted smoke detector SD located in the supply ductwork downstream of the unit shall deactivate AHU-1 whenever smoke is detected and signal alarm light "SMOKE" on AHU-1 control panel. Differential pressure switch PS shall signal indicator light "FAN ON" on AHU-1 control panel whenever fan is in operation. Differential pressure switch PS shall signal indicator light "DIRTY FILTER" on AHU-1 control panel upon sensing a clogged filter on AHU-1. A flow switch shall be installed in the ductwork to sense continuous airflow where shown on the drawings. Upon sensing low flow, a signal shall be sent to the alarm system to notify that ventilation airflow is insufficient.

END OF SECTION

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SECTION 15990
TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 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), approved by the Engineer and who specializes in the testing, balancing and adjusting of heating, ventilating and air conditioning systems. The agency shall be certified by the National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this project and having at least one Professional Engineer registered in the State in which the services are to be performed and certified by 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:
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. These 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.

1.2 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

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 hand written). 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.

1.3 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.

1.4 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° F wet bulb temperature of maximum summer design condition, and within 10°F dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS

2.1 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

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

Before operating the system perform the following steps:

A. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.

B. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return and exhaust) and temperature control diagrams.

C. Compare design to installed equipment and field installations.

D. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

E. Check filter for cleanliness.

F. Check dampers (both volume and fire) for correct and locked position and temperature control for completeness of installation before starting fans.

G. 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.

H. Determine best locations in main and branch ductwork for most accurate duct traverses. Place outlet dampers in the full open position.

I. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.2 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.

3.3 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%.

3.4 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.

3.5 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.

3.6 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

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DIVISION 16

ELECTRICAL

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SECTION 16000

ELECTRICAL POWER AND SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all electrical power and systems. 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.

1.2 DEFINITIONS

A. Provide: Furnish, install, and connect

B. Product Data: Catalog cuts and descriptive literature

C. Shop Drawings: Factory prepared specific to the installation

D. Indicated: Shown on the Contract Drawings

E. Noted: Indicated or specified elsewhere

F. Control Diagram: A control diagram shows by means of graphic symbols, the electric connections and functions of a specific circuit arrangement. The control diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

G. One-Line Diagram: A one-line diagram shows by means of single lines and graphic symbols the course of an electric circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.

H. Block Diagram: A block diagram is a portrayal of a system, instrument, computer, or program which selected portions are represented by annotated boxes and interconnecting lines.

I. Wiring Diagram: A wiring or connection diagram includes all the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or b) a panel layout drawing showing the physical location of devices plus the control diagram.

J. Interconnection Diagram: Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams which interface to the interconnection diagram. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified. All jumpers, shielding and grounding terminations not shown elsewhere shall be shown here. Signal and DC circuit polarities shall be shown. Spare wires shall be shown.

K. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements or the location to which connections are to be made.

1.3 SUBMITTALS

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

A. 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 installation.

B. 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.

C. Interconnecting diagrams depicting all cable requirements together with actual terminations as specified under paragraph 1600-1.2J.

1.4 QUALITY ASSURANCE

A. Provide complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), Standard for Electrical safety in the Workplace (NFPA 70 E), 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. National Electrical Testing Association (NETA).

1.5 WORK PROVIDED OUTSIDE THIS CONTRACT

When indicated on drawings.

1.6 WORK INCLUDED IN DIVISION 16, ELECTRICAL

A. Electrical power and systems.

B. Basic materials and methods.

C. Conduit.

D. Conductors.

E. Boxes.

F. Wiring devices.

G. Electric motors.

H. Cabinets and enclosure.

I. Instrument transformers and meters.

J. Surge arrestors

K. Surge Protection devices

L. Disconnect switches.

M. Grounding.

N. Low voltage control center.

O. Low voltage variable frequency drive.

P. Lighting Luminaires

Q. Telephone system.

R. Acceptance testing and calibration.

S. Access system.

T. Materials and equipment furnished and installed under other Divisions with raceway and electrical conductors furnished, installed, and connected under Division 16, Electrical.

U. Equipment, Instrumentation and control system components indicated on the Drawings by filled circumscribed diamond symbol.

1.7 INTENT OF DRAWINGS

Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for proper routing of raceway, subject to the approval of Engineer.

1.8 ARC SHORT CIRCUIT AND ARC FLASH RATINGS

Match existing short circuit ratings and Arc Flash labels for any circuit breaker, disconnect or control panel replaced or added under this contract.

1.9 ELECTRICAL NUMBERING SYSTEM

A. Raceway Numbers:

1. Raceways shall be tagged at all terminations. where raceway numbers have not been assigned, Contractor shall assign raceway numbers in accordance with the following system:

Error! Bookmark not defined.**Raceway Prefix**	**Type of Function**
C	Control and/or 120V or less power
H	Power above 600V
N	Pneumatic tubing
P	Power 208V to 600V
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
X	Spare

2. Prefixes shall be followed by a 5-digit equipment number. Where there is more than one raceway to a particular equipment, a letter suffix is added to distinguish the raceways.
3. Example:

   Raceway number = P31109A

   31109 = unique 5-digit equipment number

   A = Letter to distinguish from other raceways to same equipment

B. Conductor Numbers:
1. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall consist of the 5-digit equipment number followed by a dash followed by the conductor number specified on the control diagram.
2. Example:

   Tag number = 19000-L1

   Where:

   19000 = Cable number

   L1 = Conductor number
3. Conductors which are in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall

have the same conductor number. wherever possible, the conductor shall be the same as the terminal to which it connects.

4. When factory-wired equipment has terminal numbers different than the conductor number shown on the control diagram, both shall be shown on the interconnection diagram, and a copy of the interconnection diagram shall be fastened to the inside of the equipment cabinet.

1.10 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. Keep equipment upright at all times.

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

A. Provide only new products of the manufacturer's latest design.

B. Equipment shall be applied only within its rating. Equipment ratings shown are minimums. Voltage and current ratings shall be as required to adequately power the connected equipment. Fault current ratings shall be as shown for the particular item or for the next upstream device that has a fault current rating shown.

C. Shall be approved by national laboratory and listed as adequate for the classified hazardous areas as indicated on the drawings.

D. The corrosive areas are as indicated in schedule on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Maintain continuity of electric service to all portions of the process or buildings at all times. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with the City of Atlanta, the Engineer, and the electric utility company providing service to the facility. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written

authorization from the City of Atlanta.. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work.

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

C. Unless otherwise indicated, all material required to be removed and salvaged shall become the property of the City.

D. Carefully modify existing electrical equipment, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

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 Engineer all keys for electrical equipment locks. Present to the City's designated representatives, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

END OF SECTION

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SECTION 16100

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

See General conditions for submittal requirements. Drawings and general provisions of Contract, including General Conditions and Division 1 specification sections, apply to work of this section.

1.2 QUALITY CRITERIA:

Applicator shall be qualified to perform required task.

1.3 INTERRUPTION OF SERVICE:

A. Power service interruptions shall be done only with the written permission of the City of Atlanta at times so designated by the City.

B. Coordinate shutdowns of temporary power systems with other contractors so as not to delay completion of their work. Prepare to work continuously including required overtime when required, to restrict power shut down period to an absolute minimum.

C. Provide to the City in written notice in advance of any required shutdown. Make requests for shutdown in writing at least four consecutive calendar days in advance of the anticipated shutdown date.

1.4 COMPLETENESS OF WORK:

Provide all boxes, offsets, bends, raceways, raceway supports, fittings and wiring for the complete installation. Provide all components to complete the systems specified. Each unit of equipment shall be completely assembled and installed, and all surfaces shall be clean and free from dents, scratches, abrasions or marred areas.

1.5 LOCATION OF OUTLETS:

A. Outlets for lighting, power and equipment, not specifically dimensioned are located diagrammatically on the drawings. Luminaires shall be located in accordance with reflected ceiling plans or tile pattern outlines. If neither is indicated, Luminaires shall be symmetrical within the space in which they are located. Reference shall be made to the architectural, mechanical and fire protection plans and to the shop drawings of the

equipment to be installed for the exact location of the outlets. Power outlets shall be located so as to serve the equipment directly. Where new or future furniture, equipment or in built casework is indicated on Architectural plans, outlet height and position shall be coordinated by the Contractor to assure accessibility of the outlet.

B. Outlet location: May be moved 10 feet in any direction before being installed, without additional cost to the owner.

1.6 MOTORS, STARTERS AND CONTROL DEVICES:

Generally all individually mounted motor control devices will be furnished by other divisions. Where such devices are indicated on electrical drawings Division 16 Contractor shall receive device and install it complete including line and load side connections to equipment.

PART 2 - PRODUCTS

2.1 SLEEVES, OPENINGS AND FIRESAFING:

A. Exterior non membrane openings: Provide cast iron pipe sleeves for conduits passing through non membrane waterproofed exterior walls, footings, roofs or beams. Sleeves through exterior walls below grade shall have continuously welded center flange buried in construction. Make conduit watertight in sleeve with oakum packing and caulked lead joints on both sides of wall.

B. Interior membrane openings: Provide cast iron sleeves passing through interior membrane waterproofed floors with integral flashing flange and clamping ring, similar to Josam Series #1880. Adjust sleeves to floor construction with galvanized steel or wrought iron pipe nipples top and bottom, extending two inches above finished floor. Securely clamp sleeve to flashing with clamping device.

C. Exterior membrane openings: Provide cast iron sleeves passing through exterior membrane waterproofed walls, floors and roof with integral flashing flange and clamping ring, similar to Josam Series #1870 modified for required thickness. Make conduit watertight in sleeve with oakum packing and caulked lead joint.

D. Fire rated assemblies: Sleeves in slabs or in fire rated walls shall be packed with incombustible compound and caulked at ends with an incombustible compound. Provide a watertight seal at top of sleeves in slab. Seal of excess areas of floor openings around conduit and cable risers at each floor slab with a compound similar to Chase Form CTC PR 855. Provide fire safing construction which has the same fire rating as the work penetrated.

E. In electrical and mechanical rooms sleeves: Set sleeves with their top end set at least eight inches above finished floor. In addition, where sleeves pierce slabs or walls separating Machine Room Areas from Office Areas or other quiet areas, sleeves shall be packed with Fiberglass insulation to prevent noise transfer.

F. Provide flashing fittings for passing through roofs, Josam 1840 or 1830 or approved equal set at a suitable level above the roof to terminate the base flashing. Arrange conduit passing through the roofs to be a minimum of twelve inches from walls or other obstruction so as to permit proper flashing.

2.2 CONDUIT AND EQUIPMENT SUPPORTS:

A. Exposed conduit: Securely fasten in place by means of approved supports and fastenings and install with threaded fittings or types adaptable for the particular location. Hang no electric conduits on hangers with any other service and hang above all other service pipes unless otherwise shown on the contract drawings. Do not support conduit from ductwork, piping, equipment, etc.

B. Vertical support: Support vertically run conduits of less than 2” trade size at intervals not exceeding eight feet. Support such conduits, 2" trade size or larger, at intervals not greater than story height, or fifteen feet, whichever is smaller. Support conduits on heavy steel clamps bolted tightly around the conduits and anchored securely to the building structure without blocking.

C. Horizontal conduits: Securely fasten conduits in place at not more than ten foot centers, and hangers, supports or fastenings shall be provided at each elbow, at the end of each straight run.

D. Conduit in hung ceilings: Adequately support conduits by means of clamps, pipe straps or clamps designed to support conduit the structural members supporting the ceiling or to the structural slab or to the building's structural steel in the event that the ceiling system has not been installed sufficiently in advance of the conduit installation. Where feeder conduit or more than one branch conduit are installed adjacent to each other the conduit shall be supported on channels with conduit clamps mounted from the building's structural system.

E. Additional hangers: Provide at concentrated load points such as heavy equipment and pull boxes branch connections, for conduit four inches and larger, to limit conduit sag to 0.1 inch between supports.

F. Provide supporting frames or racks for work indicated as being supported from walls. Provide such frames or racks in electric and telephone closets. No work intended for surface installation in damp locations shall be

mounted directly on any wall. In such locations, flat bar members or spacers shall be used to create a minimum 1/4" air space between the walls and the work. Include in the electrical work channel sills for leveling and support of all floor mounted electrical equipment.

G. Luminaires: Support from supplemental steel attached to suspended ceiling horizontal support members or directly from the building's structural slabs or steel utilizing machine bolt expansion anchors and/or beam clamps. Fluorescent Luminaires shall be secured in place with a wire hanger at each corner, or with Luminaire clips specifically designed to secure Luminaire to the ceiling grid members.

H. Multiple hangers: Design to support a load equal to the sum of the weights of the equipment of conduits and contents, the weight of the hanger itself, plus 200 pounds. Hanger rods shall be hot dipped galvanized. Utilize single or multiple hangers as appropriate. Provide threaded rods not less than 1 1/2 inches of adjustment. Chains, wood, wire or perforated strapping shall not be used for hanging conduit or equipment.

I. Unenclosed wiring: Secure wiring in ceiling space to the structure with attachments designed for that purpose.

2.3 PRIMING AND PAINTING:

A. Painting: Each electrical enclosure including but not limited to switchboards, panelboards, cabinets, motor control centers, motor controllers, disconnects, wireways and similar enclosures shall be provided with a factory finish of not less than two coats of the manufacturer's standard color. Any finishes scratched or marred during construction shall be touched up to the satisfaction of the Architect prior to final inspection.

B. Priming: The requirements for prime painting apply only to ferrous metal materials furnished under this Section and having no factory finish, and to plywood boards. Metal surfaces shall be thoroughly cleaned of all loose rust and scale, oil, grease, or other foreign substances. Surfaces shall then be given two coats of primer. Plywood surfaces shall be given two coats of fire retardant paint.

2.4 BACK UP BOARDS:

A. Where telephone cabinets or, where two or more pieces of equipment such as safety switches, motor controllers, timers and contactors are installed in one location, provide a panel of five (5) ply three fourth (3/4) inch thick softwood face plywood with one side finished and painted black on all sides. Plywood sizes large enough to accommodate the equipment or

devices to be attached thereto. Panel shall be attached to the wall or metal frame. Plywood shall have fire retarding properties.

B. Telephone terminal boards: Provide plywood same as above and approximately 8 feet tall with horizontal dimension approximately as indicated to scale on drawings. Bottom of board shall be 12” above finished floor.

2.5 GROUNDING MATERIALS AND METHODS:

A. Ground rods: Provide copper, 3/4 inch diameter and no less than 10 feet long. Rods shall be driven such that their tops are one foot (minimum) below finished grade.

B. Grounding conductors: Provide within the building a conductor that is insulated and installed in raceway. At all points where grounding conductors enter or leave metal raceway they shall be bonded thereto. Where length of metal conduit is 5' 0" or less, bonding at one end is sufficient. Grounding conductors outside the building shall be bare, directly buried two feet (minimum) below finished grade with a non corroding runner tape one foot above the conductor the entire length.

C. Buried connections in the grounding system and connections of grounding conductors to structural columns shall be by the Cadweld process. Other connections shall be by means of UL approved clamp type connectors.

2.6 EQUIPMENT GROUND:

A. Frames and metal enclosures: Connect all electrical equipment to the equipment ground system. All raceways shall be provided with a green grounding conductor. Conductors shall be sized in accordance with Table 250-95 of the National Electrical Code or larger where so indicated.

Panelboards and feeder pull boxes: Provide a grounding conductor of capacity as required by the N.E.C. between each ground lug on the panel or transformer and the supply source. The ground bus of the normal and emergency panels shall be bonded together with a copper conductor size in accordance with Article 250 of the N.E.C.

B. Motors: Ground by means of a grounding conductor in the same raceway with the motor feeder connected to a grounding bushing at the motor terminal box, and the ground bus in the motor control center or to panel.

C. Wherever flexible conduit is used for part of a conduit run, provide a grounding conductor in the conduit and connected to a grounding bushing or bus at each end of the run.

D. Power receptacles: Ground by means of an insulated green grounding conductor terminated at the ground bus in the Branch Panelboard and to a ground terminal.

E. The ground source shall consist of building steel, a ground field as indicated on drawings, and a connection to the cold water line in the interior of the building. All ground sources shall be connected with a copper conductor, sized according to N.E.C. Table 250 94.

F. Maximum resistance to ground shall be 5 ohms.

G. Luminaires: Luminaires supplied through flexible conduit or cord shall be grounded to the box through which they receive power. This ground shall be by means of a green conductor the same size as the power conductors connected to the box and to the Luminaire by connections approved for grounding by U.L. This grounding conductor shall be installed inside the flexible conduit or be manufactured into the flexible cord.

H. Flexible Conduit: Ground continuity shall be maintained across sections of flexible conduit by means of a conductor having green colored insulation sized in accordance with Table 250 95 of the N.E.C. This conductor shall be terminated at each end and by means of approved grounding conductors attached to fixed portions of the raceway system or equipment (attachment to box or equipment cover mounting screws is unacceptable).

I. All panels provided with an equipment ground bus shall have a ground conductor returned with the feeder conductors to the main switchboard ground bus. The ground conductors shall be sized in accordance with Table 250 95 in NFPA Publication No. 70 unless noted otherwise.

2.7 FUSES

A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class RK-5 for motors and transformers for ratings 600 amp and below and Class L for feeders rated 601 amp and above.

B. Acceptable Manufacturers: Bussmann, Brush, Littelfuse or equal.

2.8 TERMINAL JUNCTION BOXES (TJB)

Provide hinged cover terminal junction boxes of the required type and size where indicated. Utilize enclosures as required in 16000-2.1. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide metal back plate for mounted terminal blocks. Provide 20 percent spare terminal points. Paint interior surfaces with white enamel or lacquer.

2.9 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, provide heavy duty, oiltight type pushbuttons, indicating lights, selector switches, and stations for these devices. Utilize General Electric Type CR104P, or equivalent by Square D, Cutler Hammer, or equal.

B. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy duty corrosion resistant, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4X stainless steel (316) enclosures. Provide special gasketing required to make complete station watertight. Utilize Square D Type SK, General Electric, Cutler Hammer, or equal.

C. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide pushbutton stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600.

D. Utilize selector switches having standard operating levers. Make all indicating lights push to test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.10 TERMINAL BLOCKS 0 TO 600 VOLTS

A. Provide 600 volt terminal blocks for termination of all control circuits entering or leaving equipment, panels, or boxes. Provide screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screws constructed of high strength and high conductivity metal. Utilize yoke that guides all strands of wire into the terminal. Utilize current bar providing dependable vibration proof connection. Supply terminals constructed to allow connection of wire without any special preparation other than stripping. Rail mount individual terminals to create a complete assembly and provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

B. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field marked tags. Supply CSA certified and UL approved terminal blocks manufactured by Weidmuller, Ideal, Electrovert, or equal.

2.11 CONTROL RELAYS

A. Provide magnetic control relays, NEMA Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control type with

field convertible contacts, and meeting the requirements of NEMA ICS Provide General Electric Type CR120B, Cutler Hammer Type M 600, or equal.

B. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a timer attachment adjustable from 0.2 to 60 seconds (minimum) and field convertible from ON delay to OFF delay and vice versa.

C. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing 01 easy manual latching and unlatching.

2.12 ELAPSED TIME METERS

Provide synchronous motor driven, elapsed time meters, to 99,999.9 hours range, nonreset type, suitable for semiflush, panel mounting. Provide General Electric Type 240, 2 ½ inch Big Look unit, Eagle Signal Bulletin 705 unit, or equal.

2.13 CIRCUIT BREAKERS, INDIVIDUAL, 0 TO 600 VOLTS:

Mount individual circuit breakers complying with requirements for circuit breakers in this section in enclosure required for the location, unless otherwise indicated. Provide circuit breakers with handles that can be locked in the OFF position. Interlock enclosure and circuit breaker to prevent opening the cover with the circuit breaker in the ON position.

2.14 CIRCUIT BREAKERS, 0 TO 600 VOLTS

A. General: Provide circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the operating handle. Do not use single pole circuit breakers with handle ties where multipole circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB 1. Circuit breakers shall have a minimum interrupting rating equal to the maximum fault current available at the point of application or they shall be part of an assembly with an integrated equipment short circuit rating at least as great as the fault current available at the point of application. Where circuit breakers are used as service entrance equipment, provide units UL labeled for that use. Provide circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. Inverse Time Type:
   1. Provide thermal magnetic circuit breaker, unless otherwise shown, for one and two pole breakers, breakers operating at 240V or less, and three pole branch circuit breakers operating at 480V.

2. Provide solid state trip circuit breakers with an adjustable short time function, unless another type breaker is required for coordination, or otherwise indicated on the Drawings, for three pole, 480V feeder circuit breakers with not more than one downstream, 480V, overcurrent protective device, excluding protective devices provided as part of a process equipment package. Such breakers shall be Eaton (formerly Westinghouse Seltronic Circuit Breakers), Square D, Type ME or PE Circuit Breakers, or equal.
3. Provide solid state trip circuit breakers with at least the following adjustment: long time pickup, long time delay, short time pickup, short time delay, I squared t, for circuit breakers not covered by either of the above cases. Such breakers shall be General Electrical Circuit Breakers with Microversatrip; Eaton (formerly Westinghouse Circuit Breakers with Digitrip); or equal.

C. Instantaneous Only Type: Instantaneous only circuit breakers shall have only an instantaneous trip element. The breakers shall be used only as part of a listed combination motor starter. Instantaneous only breakers shall be sized with a continuous rating of at least 115 percent of the full load current of the motor served. The trip setting shall be continuously adjustable from a lowest setting of not more than 700 percent to a highest setting of not less than 1,300 percent of the motor full load current. Instantaneous only breakers shall be General Electric Mag Break; Eaton (formerly Westinghouse MCP); Square D Mag Guard; or equal.

PART 3 - EXECUTION

3.1 GROUNDING METHODS:

The ground for the facility electrical system, equipment ground and building ground shall be obtained by connecting the ground bus of the panelboard to the steel in the building foundation.

3.2 GENERAL WIRING METHODS:

A. Wiring of all systems: Install wiring in a conduit, wireway, or under floor raceway systems as herein specified or as shown, unless specifically noted otherwise.

B. Wiring: Provide wiring complete from point of service connection to all receptacles, Luminaires, clocks, power outlets, outlets for future extensions, and other devices as shown. Slack wire shall be provided for all future connections. Unless otherwise specified, branch circuit conductors shall be No. 12 AWG or larger. In outlet boxes for future installations, ends of wires shall be taped and blank covers installed.

C. Cables shall not be bent either permanently or temporarily during installation to radii less than 10 times the outer dimensions.

D. Conductors not larger than No. 10 located in switchboards, motor control centers and pull boxes shall be cabled in individual circuits. Bundling and cabling shall be done with nylon straps made of self extinguishing nylon having a temperature range of 65 degrees Fahrenheit. Each strap shall be constructed with a locking hub or head on one end and a taper on the other. Straps shall be Thomas & Betts "TY RAP" or equal.

E. Luminaire connection: From an accessible approved raceway, outlet or junction box located above a suspended ceiling to recessed or surface Luminaires, provide minimum 3/8 inch flexible metallic conduit at least 4 feet and not more than 6 feet in length where indicated on drawings. The outlet or junction box shall be located a minimum of one foot and not more than 4 feet from the Luminaire. Additional raceways, outlet or junction boxes including conduit or electric metallic tubing extensions to those shown on the drawings, shall be provided where required to comply with the above length requirements. Minimum size No. 12 AWG phase and neutral conductors shall be installed as specified in flexible metallic conduit connections to Luminaire wireways shall be considered branch circuit conductors for the purpose of this specification.

END OF SECTION

SECTION 16110

RACEWAYS, BOXES, AND SUPPORTS

PART 1 - GENERAL

1.1 SCOPE

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.2 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 the listed documents, the requirements of this section shall prevail.

REFERENCE	**Title**
ANSI	Rigid Steel Conduit-Zinc Coated
ANSI	Electrical Metallic Tubing-Zinc Coated
ASTM	Smooth-Wall Polyvinylchloride Conduit And Fittings For Underground Installation
FEDSPEC	Conduit, Metal, Rigid And Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Zinc Coated
FEDSPEC	Conduit And Conduit Fittings, Plastic, Rigid
NEMA	Industrial Control And Systems Enclosures
NEMA	Electrical Plastic Tubing (EPT) And Conduit (EPC 40 And EPC 80)
NEMA	Pvc And Abs Plastic Utilities Duct For Underground Installation
NEMA	Cable Tray Systems
NEMA	Enclosures For Electrical Equipment (1000 Volts Maximum)

NFPA 70	National Electrical Code (Nec)
UL	Flexible Metal Electrical Conduit
UL	Rigid Metal Electrical Conduit
UL	Liquid Tight Flexible Electrical Conduit
UL	Rigid Nonmetal Electrical Conduit
UL	Electrical Metallic Tubing

1.3 SUBMITTALS

The following information shall be provided in accordance with the General Conditions:

A. Manufacturer's descriptive literature for all materials.

B. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (□) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by 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.

PART 2 - PRODUCTS

2.1 BOXES AND FITTINGS

A. PULL BOXES AND WIRING GUTTERS:

Indoor boxes larger than FD boxes shall be constructed of sheet steel and galvanized after fabrication. Similar enclosures in wet or outdoor areas shall be NEMA 4X. Equipment shall be suitable for the environment in which it is installed. Box and gutter sizes, metal thickness, and grounding shall comply with the National Electrical Code. Bolt on junction box

covers 3 feet square or larger, or heavier than 25 pounds, shall have a rigid handle. Covers larger than 3 by 4 feet shall be split.

B. TERMINAL CABINETS:

Terminal cabinets located indoors shall be NEMA 12. Cabinets located outdoors and in corrosive areas shall be NEMA 4X. Cabinets shall be provided with hinged doors. Adjustable terminal strip mounting accessories shall be provided. Cabinets shall be provided with channel mounted terminal blocks.

C. MANHOLES:

Unless otherwise specified, manholes shall be precast concrete, 3000 psi strength at 28 days, with reinforcing and cover designed for H-20 bridge loading. Manhole dimensions shall be as indicated on the drawings. Necking and shaft shall have 36-inch minimum clear opening.

Manhole cover and frame shall be Class 30B grey cast iron per ASTM A48 with machine finished flat bearing surfaces. Manholes shall be watertight. Exterior walls of manholes shall be provided with 6 mils of waterproof membrane, Sonneborn HLM 5000 Series, or equal.

Duct entrees shall be no less than 14 inches above floor and below ceiling. Cables supports, clamps or racks shall be provided to support the cable at minimum 2-foot intervals. Concrete inserts shall be embedded in walls and ceiling. Floor shall slope 2 percent in all directions to a sump. Sump shall be a minimum of 18 by 18 by 12 inches deep.

Manhole walls shall be provided with boxouts with waterstops on all sides of each boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section. Boxouts shall be sized to accommodate the penetrating underground duct banks.

D. HANDHOLES:

Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H-20 loading. Dimensions shall be as specified on the drawings. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be constructed of 3000 psi reinforced concrete. Handhole cover shall be engraved "ELECTRICAL" or "SIGNAL" as applicable.

Handhole walls shall be provided with boxouts, as specified for manholes.

2.2 RACEWAY SUPPORTS

A. CONDUIT SUPPORTS:

Hot-dip galvanized framing channel with end caps shall be provided to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit supports for PVC coated rigid steel and PVC conduit systems shall be one-hole PVC coated rigid steel or clamps conduit wall hangers.

B. CEILING HANGERS:

Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. SUSPENDED RACEWAY SUPPORTS (RACKS):

Suspended raceway supports shall consist of concrete inserts, galvanized carbon steel rod hangers, and jamb nuts supporting hot dip galvanized framing channel or lay-in pipe hangers as required. Hanger rods shall be 1/2 inch all-thread rod and shall meet ASTM A193, unless otherwise specified. All suspended raceway supports shall be braced at 30-foot intervals (alternating from one side to the other) to meet specified seismic requirements.

2.3 CONCRETE ENCASED DUCT BANKS

Concrete used for duct banks shall be Class E with red oxide added as specified in the Cast-in-Place Concrete section.

2.4 UNDERGROUND MARKING TAPE

Underground marking tape shall be for early warning protection of digging around reinforced concrete duct banks. Tape shall be low density polyethylene plastic, nominally 6 inches wide and 4 mil thickness. The plastic color shall be red. A warning shall be imprinted continuously along the length, with message reading similar to "CAUTION - STOP DIGGING - BURIED ELECTRIC LINE BELOW." Tape shall be Brady "Identoline"; Services and Materials "Buried Underground Tape"; Somerset (Thomas & Betts) "Protect-A-Line"; or equal.

Underground marking tape for directly buried cables and conduits shall be 6-inch wide metallic lined tape with red polyethylene film on top and clear polyethylene film on the bottom. The message shall be clearly printed with black over red tape and shall read "CAUTION ELECTRIC LINE BURIED BELOW".

2.5 NAMEPLATES

Nameplates shall be provided for all boxes in accordance with the requirements of Section 16000. Nameplate wording shall be as indicated on the drawings. Where no wording is specified, the Contractor shall provide the functional description of the device on the nameplate.

2.6 FIRESTOPS

Firestops and seals shall be Flamemastic 77, Vimasco No. 1-A, or equal, and shall be applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

2.7 RACEWAY IDENTIFICATION

Raceway number tags shall conform to the requirements of raceway markers, Section 16000.

PART 3 - EXECUTION

3.1 MANHOLES AND HANDHOLES

Unless otherwise specified, manhole and handhole installation shall be as follows:

A. Manholes and handholes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.
B. Manholes and handholes shall be set plumb, so that water shall drain properly to the sump.
C. Manhole covers, unless otherwise specified, shall be set at 1 to 2 inches above finish grade with surrounding pavement sloping away from the manhole cover.
D. All metallic hardware inside manholes and handholes shall be grounded by connection to the ground plate. Connections shall be made using bolted connections, bonding jumpers and grounding bushings.

3.2 RACEWAY NUMBERING

Each conduit shall be provided with a number tag at each end and in each manhole and/or pull box. Trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end.

3.3 RACEWAY SCHEDULE

A. GENERAL:

The Raceway Schedule is on the drawings.

B. UNSCHEDULED RACEWAY:

With the exception of lighting, communication, paging, fire alarm, security and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules. Lighting and receptacle raceway are unscheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

The number and size of communication, paging, fire alarm, and security raceways shall be as required for the particular equipment provided subject to the minimum sizes specified above.

+++ END OF SECTION +++

SECTION 16111

CONDUIT

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of conduit, including rigid metal conduit and fittings, flexible metal conduit and fittings, liquidtight flexible metal conduit and fittings, non-metallic conduit and fittings, explosion proof flexible steel conduit, manholes, handholes and ductbanks. All conduit 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.

1.2 SUBMITTALS

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

A. Equipment data specified in this Section.
B. Catalog cuts.

1.3 QUALITY ASSURANCE

Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ANSI C80.1
B. ASTM F 512
C. Fed Spec WW-C-581E
D. Fed Spec WW-C-1094A
E. NEMA TC2
F. NEMA TC6

G. NFPA 70
H. UL 1
I. UL 6
J. UL 360
K. UL 651

1.4 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards, and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:
1. Conduit: Allied, Republic, Triangle, Wheatland or equal.
2. PVC Coated Conduit: Permacote, Robroy or equal.
3. PVC Conduit: Amoco, Carlon, Certainteed or equal.
4. Flexible Conduit: Anamet, Columbia, Electrilex or equal.
5. Fittings: Appleton, Crouse-Hinds, Thomas & Betts or equal.

PART 2 - PRODUCTS

2.1 GENERAL

The type and size of raceway shall be as specified on the Drawings or schedules. Lighting and receptacle raceways are not scheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be ¾-inch for exposed and 1-inch for embedded raceway. The number and size of communication and security raceways shall be as required for the particular equipment provided, subject to the minimum sizes specified above.

2.2 RIGID METAL CONDUIT AND FITTINGS

A. Rigid Steel Conduit: UL 6; ANSI C80.1; hot dip galvanized. Minimum size 3/4-inch, exposed, 1-inch embedded or inaccessible.

B. PVC Coated Conduit: NEMA RN-1; galvanized rigid steel conduit with factory applied external 40 mil PVC coating and 2 mil urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. Minimum size ¾-inch.

C. Fittings and Conduit Bodies: NEMA FBI; 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, and other accessories are to be PVC coated.

2.3 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating. Minimum size ½-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; malleable iron squeeze type.

2.4 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.

B. Fittings and Conduit Bodies: NEMA FB-1; galvanized steel compression type with 0-ring.

2.5 RIGID NONMETALLIC CONDUIT AND FITTINGS

A. Use rigid PVC Schedule 40 conduit, UL listed for concrete encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W C 1094, UL, NEC, and ASTM specified tests for the intended use. Use only conduit with a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable. Minimum size ¾-inch exposed, 1-inch embedded or encased.

B. Fittings for PVC conduit shall comply with Standard for PVC Fittings for use with Rigid Conduit and Tubing, NEMA TC3, and shall be NEMA Type IV.

2.6 EXPLOSION PROOF FLEXIBLE STEEL CONDUIT

Conduit shall be suitable for use in Class 1, Division 1, Groups C and D hazardous areas as specified in NEC and shall be watertight. Flexible conduit shall be used for final connections to motors and other equipment subject to vibration or adjustment in Class 1, Division 1 hazardous areas. Minimum size ½-inch.

2.7 WARNING TAPE

Provide heavy gauge, yellow plastic tape of 6 inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: ITT Blackburn Type YT or RT; Griffolyn Co. Terra Tape; or equal.

2.8 RACEWAY IDENTIFICATION

Raceways number tags shall be brass with stainless steel attachment wire. Raceway number shall be embossed on to the tag with ¼-inch letters.

PART 3 - EXECUTION

3.1 CONDUIT SCHEDULE

A. Refer to Contract Drawings for conduit schedules.

B. Use rigid steel conduits for indoor clean area.

C. Use liquid-tight flexible steel conduit for connections to motors, transformers, and other vibrating equipment.

D. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.

E. Use PVC coated conduits where conduits are in direct contact with earth or where conduits are installed in corrosive areas.

F. Use PVC conduits where conduits are embedded in concrete structures, encased in concrete duct bank or concealed in concrete block CMU.

G. Where PVC conduit is indicated, make a transition to PVC coated rigid steel below grade or slab and continue above with PVC coated rigid steel conduit. Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures.

3.2 CONDUIT ARRANGEMENT AND SUPPORT

A. Arrange conduit to maintain headroom and present a neat appearance. Run 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.

B. Avoid sources of heat when possible. Where unavoidable, maintain 6-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 galvanized steel channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.

D. Support conduit at a maximum of 7 feet on center and within 3 feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.

3.3 CONDUIT INSTALLATION

A. In the event of any conflict between this section and Section 16114, this section shall govern.

B. Cut conduit square using a saw or pipe cutter and de-burr and ream 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.

C. Use conduit hubs for fastening conduit to boxes. 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.

D. The maximum length between pull points is 400 feet. This length shall be reduced by 100 foot for each 90 degree of bend.

E. The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

F. Use hydraulic one-shot shoe bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.

G. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

H. 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.

I. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box.

J. Provide a 200 pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

K. Install expansion joints where conduit crosses building expansions joints and for straight runs in excess of 100 feet. See additional information in Section 16114.

L. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

M. 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.

N. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

O. Conduits shall be installed between the reinforcing steel in walls or slabs which have reinforcing in both faces. In slabs which have only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.

P. PVC conduit bends: Use PVC-coated rigid steel factory elbows.

Q. 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.

R. Provide sealing compound equal to Chico A or Chico B where conduit passes from hazardous or corrosive area in to a non-classified area.

S. Each conduit shall be provided with a number tag at each end.

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 entries.

D. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than 4 feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement. Stagger conduit joints in concrete encasement 6-inches minimum.

E. Construct duct banks with 3,000 psi concrete. Provide reinforcing bars as indicated. Each 50 lb. bag of concrete shall include 3 lbs of red oxide.

F. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the ductbank and the structure.

G. Thoroughly swab inside of conduits upon completion of pouring concrete. Before backfilling , a mandrel, ½-inch smaller than the conduit diameter, shall be pulled through each conduit.

END OF SECTION

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SECTION 16114
EXPANSION DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

See General Conditions for submittal requirements. Drawings and general provisions of Contract, including General Conditions and Division-1 specification sections apply to work in this section.

1.2 QUALITY CRITERIA:
INSTALLER shall be qualified to perform required task.

1.3 COMPLETENESS OF WORK:
Provide all boxes, offsets, bends, raceways, raceway supports, and fittings for the complete installation. Provide all components to complete the systems specified. Each unit of equipment shall be completely assembled and installed, and all surfaces shall be clean and free from dents, scratches, abrasions or marred areas. Any application of material or equipment from his section shall maintain fire rating and classified location ratings of existing walls, slabs, ceilings and building areas.

1.4 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit expansion and deflection fittings where necessary for conduit thermal expansion or where crossing structural expansion joints. Coordinate location with ENGINEER.
2. Alternatively, contractor may install bends in the piping runs to accommodate expansion and contraction. Coordination locations with ENGINEER.

1.5 REFERENCES

A. Standards referenced in this Section are:
1. UL 514B, Conduit, Tubing, and Cable Fittings.
2. UL 467, Grounding and Bonding Equipment.

1.6 QUALITY ASSURANCE
Regulatory Requirements: Comply with the following:
NEC Article 300, Wiring Methods.

1.7 SUBMITTALS

Action Submittals: Submit the following:

A. Shop Drawings:
Listing of locations where fittings are required.

B. Product Data:
Manufacturer's literature and technical information for expansion and deflection fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Products and Manufacturers: Provide one of the following:
1. Type DX for expansion/deflection or AX for expansion only, by O Z Gedney Company.
2. Type XD for expansion/deflection or XJ for expansion only, by Crouse Hinds Company.
3. Type DF for expansion/deflection or XJ for expansion only, by Appleton Electric Company.
4. Or equal.

B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot-dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion resistant, UL-listed, and compatible with the conduit system.

C. Features:
1. Expansion/Deflection Fittings:
   a. Axial expansion or contraction up to 3/4-inch.
   b. Angular misalignment up to 30 degrees.
   c. Parallel misalignment up to 3/4-inch.
2. Expansion Fittings:
   Expansion/Contraction: Eight-inch total movement.

D. Expansion/Deflection fittings shall comply with UL 514B and UL 467.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install fittings in accordance with Laws and Regulations.

B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.

C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.

D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/ deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.

E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.

F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

END OF SECTION

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SECTION 16121

INSTRUMENTATION AND COMMUNICATION CABLE

PART 1 - GENERAL

1.1 DESCRIPTION

Scope:

A. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.

B. Types of cables include the following:
   1. Shielded instrumentation cables.
   2. Data communication cables.

1.2 TERMINOLOGY

The following words or terms are not defined but, when used in this Section, have the following meaning:

A. "CPE" means chlorinated polyethylene.

B. "FEP" means fluorinated ethylene-propylene.

C. "XLPE" means cross-linked polyethylene.

1.3 REFERENCES

Standards referenced in this Section are:

A. ASTM A510, Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.

B. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

C. ANSI/TIA/EIA-568, Commercial Building Telecommunications Cabling (requirements and restrictions of Technical Service Bulletins (TSBs) apply.)

D. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).

E. UL 13, Power-Limited Circuit Cables.

F. UL 1581, Electrical Wires, Cables and Flexible Cords.

G. UL VW-1, Vertical Wire Flame Test.

H. UL 910, Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.4 QUALITY ASSURANCE

Regulatory Requirements:

A. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.

B. NEC 727, Instrumentation Tray Cable.

C. NEC 800, Communications Circuits.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.

B. Informational Submittals: Submit the following:
Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
Cables shall bear the UL labeled.

B. Single Shielded Pair Instrument Cables:
1. Manufacturers: Provide products of one of the following:
   a. Belden Company.
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or equal.
2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.

C. Multi-Paired Shielded Instrument Cables:
1. Manufacturers: Provide products of one of the following:

a. Belden Company.
b. Okonite Company.
c. Dekoron Wire and Cable Company.
d. Or equal.

2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.

D. Multi-Conductor Shielded Instrument Cables:

1. Manufacturers: Provide products of one of the following:
   a. Belden Company.
   b. Okonite Company.
   c. Dekoron Wire and Cable Company.
   d. Or equal.
2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.

E. Cable Terminals:

1. Manufacturers: Provide products of one of the following:
   a. T&B Sta-Kon.
   b. Burndy Insulug.
   c. Or equal.
2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

General:

A. Install cables complete with proper terminations at both ends.

B. Install in conduit separate from power cables, unless shown or indicated otherwise.

C. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.

D. Identify conductors in accordance with Section 16195, Identification for Electrical Systems.

E. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.

F. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

Site Tests:

A. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.

B. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.

C. Replace with new cables the full length of cables that fail test.

D. Test equipment shall be provided by CONTRACTOR.

E. For testing of communications cables, test equipment used shall comply with the following:
   1. Equipment shall consist of a "master" and a "remote" unit.
   2. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
   3. Test unit shall be capable of storing all test results internally and printing the results later.
   4. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category

END OF SECTION

SECTION 16122
MEDIUM VOLTAGE CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

Scope: CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install medium voltage cable.

1.2 REFERENCES

Standards referenced in this Section are:

A. AEIC CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 through 46 kV.
B. ANSI C2, National Electrical Safety Code.
C. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems
D. ASTM B3, Specification for Soft or Annealed Copper Wire
E. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
F. ASTM B33, Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
G. ICEA S-93-639, 5-46 KV Shielded Power Cables for use in the Trans-mission and Distribution of Electric Energy.
H. IEEE 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5kv through 765kv.
I. IEEE 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500 000 V
J. UL 1072, Medium-Voltage Power Cables.

1.3 QUALITY ASSURANCE

A. Qualifications:
   Independent Testing Agency:
   1. Retain services of independent testing agency for field quality control testing of installed medium voltage cables.
   2. Testing agency shall have experience inspecting and testing cables of type specified, and shall be a member company of NETA.
   3. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall be in accordance with ANSI/NETA ATS.

B. Regulatory Requirements:

1. Tests by Independent Agencies: Cable shall bear label of Underwriters Laboratories, Inc.
2. Utilities: Georgia Power Co.
   Perform Work in connection with utility service in conformance with requirements of (--1--).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Literature identifying the methods and materials proposed for making splices and terminations. Submittal shall consist of manufacturer literature evidencing compatibility of conductor insulation, shield, and jacket of cable with splicing or terminating materials, and methods proposed for use.
      b. Listing of locations where splices are proposed.
   2. Product Data:
      Manufacturer's literature and technical information indicating compliance with the Contract Documents.

B. Closeout Submittals: Submit the following:
   Record Documentation:
   Include on record documents actual location and routing of medium voltage cable installations in accordance with Specification section for Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Cable provided under this Section shall be rated for insulation level of 133 percent at five KV.
   2. Cable insulation shall be thermosetting rubber-based suitable for normal installation indoors or outdoors, in conduit, in air, and intermittent or continuous submergence in water.
   3. Cable shall be single conductor bearing UL label "MV 105" and comply with or exceed applicable ICEA and AEIC standards.

B. Manufacturers: Provide products of one of the following:
   1. Kerite Company.
   2. The Okonite Company.
   3. General Cable Corporation.
   4. Southwire.
   5. Or equal.

C. Materials:
   1. Conductor: Conductors shall be soft or annealed uncoated or tinned coated copper with concentric-lay Class B round stranding in accordance with ASTM B8, and ASTM B3 or ASTM B33.
   2. Insulation System: Cable insulation system shall include two separate screen layers, primary insulation and shield.
      a. Conductor screen shall consist of extruded inner layer of non-conducting energy suppression or semi-conducting material. Conductor screen shall be in intimate contact with outer surface of conductor.
      b. Primary insulation shall be high quality ozone-resistant ethylene-propylene rubber based compound. Insulation system shall be suitable for use at conductor temperatures not exceeding 90 degrees C for normal operation, 130 degrees C for emergency overload conditions, and 250 degrees C for short circuit conditions. Minimum and maximum thickness of insulation system shall be 85/120 mils for five kV systems, 210/220 mils for 15 kV systems, and 400/450 mils for 35 kV systems.
      c. Insulation screen shall be outer layer of thermosetting semi-conducting material. Insulation screen shall be in intimate contact with outer insulation surface.
      d. Insulation shield shall be a five-mil copper tape applied helically with minimum 12.5 percent overlap.
   3. Jacket: Continuous jacket of moisture, heat, oil resistant black polyvinyl chloride shall be applied over insulation and shielding system. Minimum thickness of jacket shall be in accordance with ICEA.

D. Cable Connectors:
   1. Connectors shall be copper, tin-plated, long-barrel compression type. Suitable for voltage applications up to 35 KV.
   2. For sizes 250 MCM and larger, connectors shall be two-hole mount type with provisions for two bolts for joining to apparatus terminal.
   3. Manufacturers: Provide products of one of the following:
      a. FCI-Burndy.
      b. T&B Connectors.
      c. Or equal.

E. Cable Terminations:
   1. Cable terminations shall comply with Class 1 requirements of IEEE 48.
   2. Terminations shall be molded elastomer, wet-process porcelain or heat-shrinkable types with grounding provisions for cable shielding.
   3. Manufacturers: Provide products of one of the following:
      a. Elastimold.
      b. G&W Electric Company.
      c. Raychem Corporation.
      d. 3M Company.
      e. Or equal.

F. Cable Splices:
   1. Make cable splices using standard splice kits that reinstate cable's insulation and jacket and continue metallic shielding through entire cable joint.
   2. Splices shall be premolded, conventional tape or heat-shrinkable type.
   3. Manufacturers: Provide products of one of the following:
      a. Elastimold.
      b. G&W Electric Company.
      c. Raychem Corporation.
      d. 3M Company.
      e. Or equal.

G. Pulling Compound:
   1. Provide pulling compound to facilitate wiring pulling. Compound shall be UL-listed, waxed or water based type. Compound shall be compatible with all jacket types.
   2. Pulling tension coefficient of friction shall not exceed 0.35.
   3. Use winter-grade compound for outdoor, low-temperature installations.
   4. Manufacturers: Provide products of one of the following:
      a. Ideal Industries.
      b. Greenlee.
      c. Or equal.

F. Fireproofing Tape for Cables in Manholes, Handholes, and Boxes:
   1. Tape shall be 30-mils thick of self-extinguishing material that does not support combustion. Tape shall not deteriorate when subjected to water, salt, sewage, or fungus
   2. Secure tape with glass cloth tape.

G. Color code cables by applying general purpose, flame-retardant tape, wrapped in overlapping turns covering an area of at least two inches. Colors shall be as follows:
   1. Grounded Neutral: White.
   2. Phase A: Brown.
   3. Phase B: Orange.
   4. Phase C: Yellow.

   MV cable Color coding shall be confirmed with City of Atlanta Standards and submitted for approval during shop drawing submittal.

2.2 SOURCE QUALITY CONTROL

Factory Testing:

A. Cables shall be factory tested in accordance with testing standards of ICEA and UL.

B. Conductors shall comply with electrical resistance requirements of ICEA.
C. Perform insulation resistance test in accordance with ICEA. Each cable shall have an insulation resistance not less than that corresponding to insulation resistance constant of 20,000 megohms-1000 feet at 15.6 degrees C.
D. Perform high voltage AC test in accordance with ICEA.
E. Measure and record shield resistance from end to end on completed cable.
F. Corona Test: Each reel of completed shielded power cable shall be partial discharge tested in accordance with ICEA.
G. Record cable physical measurements.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check for proper phase sequence and proper motor rotation.

B. Splice and terminate medium voltage cables in accordance with cable manufacturer's recommendations.
   1. Use experienced personnel familiar with materials and procedures to be employed.
   2. Make splices watertight for below-grade installations, and submersible in manholes and handholes.

C. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within limits recommended by cable manufacturer.
   3. Use dynamometer when mechanical means are used.
   4. Cut off section subject to mechanical means.

D. Bending Radius: Limit to twelve times cable overall diameter.

E. Slack: Provide maximum slack at terminal points and in manholes.

F. Wrap cables located within manholes, handholes, and boxes with fireproofing tape for cable's entire length for each individual cable. Secure fireproofing tape with glass cloth tape. Fireproof cables in accordance with cable manufacturer's recommendations, and cover cables with tape extending at least one inch into each duct.

G. Identification: Identify conductors by circuit number and phase at each terminal or splice location.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform acceptance testing of medium voltage cable system. Each cable circuit shall be inspected and tested on an individual, per-phase basis. Testing and inspection shall be performed by independent testing agency.
2. Visual and Mechanical Inspection: Inspect each power cable installation in accordance with ANSI/NETA ATS. Inspect each splice and termination.
3. Electrical Tests: Perform electrical testing of each power cable in accordance with ANSI/NETA ATS and manufacturer's recommended testing procedures. Testing shall include:
    a. Shield continuity test.
    b. DC or AC high potential test.
    c. Adhere to following procedures before performing over-potential tests:
        1) Disconnect all equipment, including but not limited to: transformers, switches, motors, circuit breakers, and surge arrestors from cable circuit to prevent test interruptions due to flashovers or trip-outs resulting from excessive leakage current.
        2) Establish adequate clearance between circuit test ends and grounded objects and to other equipment not under test.
        3) Ground all circuit conductors not being tested, all cables shields, and nearby equipment.
        4) Clean insulation surfaces.
        5) Keep cable ends dry.
    d. Apply high-potential slowly in eight to ten equal steps to 80 percent of manufacturer's test value. Record leakage current at each test voltage and plot resulting curve on graph paper.
    e. Stop the test if leakage current increases excessively or if a "knee" appears in the curve before reaching maximum test voltage.
    f. Upon reaching specified maximum test voltage, maintain voltage for 15 minutes, record leakage current at 30 seconds, one minute, and at one-minute intervals thereafter. Plot leakage current versus time on the same graph as step voltage curve.
    g. Reduce conductor test potential to zero and measure residual voltage at discrete intervals.
    h. Apply grounds for a period adequate to drain all insulation stored charge.
    i. Replace and retest new cable that fails tests.
    j. Test curves shall be signed by the individual performing tests and submitted to the ENGINEER.
    k. The intent of this section and the above paragraphs apply to medium voltage cable reused only when specifically requested in the drawings. For the purpose of this scope, any medium voltage cable being affected via electrical equipment replacement such as transformers, switchgear, MCC, or motor feeders shall be installed new, and tested per sections A1-3.

END OF SECTION

SECTION 16123

BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.1 SCOPE

The contractor shall install all building wire and cable; nonmetallic-sheathed cable; direct burial cable; service entrance cable; armored cable; metal clad cable; and wiring connectors and connections as specified herein and as shown on the electrical drawings.

1.2 SECTION INCLUDES

A. Product Requirements: Provide products as follows:
   1. Stranded conductor for feeders and branch circuits 10 AWG and smaller.
   2. Stranded conductors for control circuits.
   3. Conductor not smaller than 12 AWG for power and lighting circuits.
   4. Conductor not smaller than 16 AWG for control circuits.
   5. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
   6. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.

B. Wiring Methods: Provide the following wiring methods:
   1. Concealed Dry Interior Locations: Use only building wire THHN/THWN insulation in raceway.
   2. Exposed Dry Interior Locations: Use only building wire THHN/THWN insulation in raceway.
   3. Above Accessible Ceilings: Use only building wire THHN/THWN in raceway.
   4. Wet or Damp Interior Locations: Use only building wire THHN/THWN insulation in raceway.
   5. Exterior Locations: Use only building wire THHN/THWN insulation in raceway.
   6. Underground Locations: Use only building wire THHN/THWN insulation in raceway.
   7. Conductor sizes are based on copper.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog information showing dimensions, colors and configurations.

B. Test Reports: Indicate procedures and values obtained.

C. Manufacturer's Installation Instructions

D. Product Data: Submit for building.

E. Samples:
1. Submit 1 each, 18 inch length of cable assembly from each reel.
2. Select each length to include complete set of manufacturer markings.
3. Attach tag indicating cable size and application information.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.5 RELATED SECTIONS

A. International Electrical Testing Association: NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

B. National Fire Protection Association: NFPA 70 - National Electrical Code.

1.6 CLOSEOUT SUBMITTALS

Project Record Documents: Record actual locations of components and circuits.

1.7 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 FIELD MEASUREMENTS

Verify field measurements are as indicated on Drawings.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Manufacturers:

1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Okonite Co.
5. Anixter
6. Southwire

B. Product Description: Single conductor insulated wire.

C. Conductor: Copper.

D. Insulation: Thermoplastic material rated 75 degrees C for interior distribution. Use 90 degree C rated materials for exterior, exposed conduit runs.

2.2 NONMETALLIC-SHEATHED CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Okonite Co.
5. Anixter
6. Southwire

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

2.3 DIRECT BURIAL CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Okonite Co.
5. Anixter
6. Southwire

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

2.4 ARMORED CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.

3. General Cable Co.
4. Okonite Co.
5. Anixter
6. Southwire

B. Conductor: Copper

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 degrees C.

E. Insulation Material: Thermoplastic.

F. Conductor Assembly Covering: Lead.

2.5 METAL CLAD CABLE

A. Manufacturers:
1. Diamond Wire & Cable Co.
2. Essex Group Inc.
3. General Cable Co.
4. Okonite Co.
5. Anixter
6. Southwire

B. Conductor: Copper.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 degrees C.

E. Insulation Material: Thermoplastic.

F. Armor Material: Aluminum.

G. Armor Design: Corrugated tube.

2.6 VFD CABLE

A. Manufacturers:
1. Okonite Co.
2. Anixter
3. Southwire
4. Or approved equal

B. Conductor: Stranded tinned copper. Wire sizes should not be smaller than No. 12 AWG for power and NO. 14 AWG for 120-volt control circuits.

C. Insulation Voltage Rating: 600 volts.

D. Insulation Temperature Rating: 75 degrees C or 90 degrees C

E. Insulation Material: Thermoset

F. Approval: Type TC-ER perUL 1277, UL Type MTW. NFPA 79 2018, Wet Rating 75 degrees Celsius rated, Oil Resistant 1. DP-1 90 degrees Celsius, UL-AWM. Sunlight resistant and direct buried rated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify interior of building has been protected from weather.

B. Verify mechanical work likely to damage wire and cable has been completed.

C. Verify raceway installation is complete and supported.

3.2 EXISTING WORK

A. Remove exposed abandoned wire and cable including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.

B. Disconnect abandoned circuits and remove circuit wire and cable. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.

C. Provide access to existing wiring connections remaining active and requiring access. Modify installation or install access panel.

D. Extend existing circuits using materials and methods compatible with existing electrical installations, when specifically required by the drawings; otherwise rewire new as part of this scope. When directed to utilize existing wiring and conduit, test material per NETA MTS before placing in service. Provide test results for approval by the ENGINEER before placing installation back into service.

3.3 INSTALLATION

A. Route wire and cable to meet Project conditions.

B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

C. Identify and color code wire and cable. Identify each conductor with its circuit number or other designation indicated.

D. Neutrals: Run separate neutral wire for each phase load. The neutral wire shall not be shared in 3 phase 4 wire systems.

E. Special Techniques--Building Wire in Raceway:
1. Pull conductors into raceway at same time.
2. Install building wire 4 AWG and larger with pulling equipment.

F. Special Techniques - Cable:
1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or metal cable ties to support cables from structure or ceiling suspension system. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

G. Special Techniques - Direct Burial Cable:
1. Trench and backfill for direct burial cable installation. Install warning tape along entire length of direct burial cable, within 3 inches of grade.
2. Use suitable direct burial cable fittings and connectors.

H. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor.
4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
5. Install solder less pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
7. Install solid conductor for feeders and branch circuits 10 AWG and smaller.
8. Install stranded conductors for branch circuits 10 AWG and smaller. However, when stranded conductors are used in lieu of solid, and then install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.

3.4 WIRE COLOR

A. General
1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
a. Black and red for single phase circuits at 120/240 volts.

b. Black, red, and blue for circuits at 120/208 volts single or three phase.
c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
d. Black, Red, Blue for circuits at 575 volts.

2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Colors are as follows:
a. Black and red for single phase circuits at 120/240 volts.
b. Black, red, and blue for circuits at 120/208 volts single or three phase.
c. Orange, brown, and yellow for circuits at 277/480 volts single or three phase.
d. Black, Red, Blue for circuits at 575 volts.

B. Neutral Conductors: White or Gray. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.

C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.

D. Feeder Circuit Conductors: Uniquely color code each phase.

E. Ground Conductors:
1. For 6 AWG and smaller: Green.
2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

PART 4 - FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.3.1.

END OF SECTION

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SECTION 16131
SEALED FITTINGS

PART 1 – GENERAL

1.1 DESCRIPTION

Scope:
CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit sealing fittings with sealing fiber and sealing compound.

1.2 REFERENCES

UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations, Class 1, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 QUALITY ASSURANCE

Regulatory Requirements: Comply with the following:
NEC Article 500, Hazardous (Classified) Locations.

1.4 SUBMITTALS

A. Shop Drawings:
Listing of locations where fittings are to be used.
B. Product Data:
Manufacturer's literature and technical information for sealing fittings, sealing fiber, and sealing compound proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Manufacturers: Provide products of one of the following:
1. Crouse Hinds Company.
2. Appleton Electric Company.
3. Or equal.

B. Materials and Construction:
1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
2. Ample opening with threaded closure for access to conduit hub for making dam.

3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
4. Construct fitting to allow 40 percent cross-sectional fill.

C. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished, and shall be products of fitting manufacturer.

D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install for hazardous locations as required by Laws and Regulations and as shown.

B. Provide fittings for proper use relative to mounting position.

C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

The contractor shall furnish and install all switches and receptacles for lighting and miscellaneous power applications on the type and at the locations as specified herein and as shown on the electrical drawings.

1.2 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Poke-through service fittings.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

B. Manufacturer's Installation Instructions.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.5 RELATED SECTIONS

A. Section 16100 – Basic Materials and Methods

B. Section 16123 – Building Wire and Cable

C. Section 16510 – Interior Luminaires

D. Section 16160 – Panelboards

E. Section 16520 – Exterior Luminaires

1.6 REFERENCES

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

1.7 SUPPLIES & SPARE PARTS

A. The contactor shall furnish 10% (minimum of 1) spare each recepticle, switch and plug furnished and installed for this project.

B. Spare parts lists, included with shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate part inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same number

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Wiring Devices; www.cooperwiringdevices.com.

B. GE Industrial; www.geindustrial.com.

C. Leviton Manufacturing, Inc; www.leviton.com.

2.2 WALL SWITCHES

A. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: Ivory plastic with toggle handle.
   2. Indicator Light: Lighted handle type switch; red handle.
   3. Locator Light: Lighted handle type switch; red color handle.
   4. Ratings:
      a. Voltage: 120 volts, AC.
      b. Current: 20 amperes.

B. Switch Types: Single pole, double pole, and 3-way.

2.3 RECEPTACLES

A. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
   1. Device Body: Ivory plastic.
   2. Configuration: NEMA WD 6, type as specified and indicated.

B. Convenience Receptacles: Type 5 - 15.

C. Single Convenience Receptacles.

D. Duplex Convenience Receptacles.

E. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.4 WALL PLATES

A. Jumbo Cover Plates: Ivory, smooth plastic.

B. Weatherproof Cover Plates: Gasketed cast metal with hinged.

2.5 POKE-THROUGH FITTINGS

A. Manufacturers:
   1. Hubbell Wiring Devices - Kellems; www.hubbell-wiring.com
   2. Thomas & Betts Corporation; www.tnb.com
   3. The Wiremold Company; www.wiremold.com

B. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
   1. Fire Rating: 3 hours.
   2. Type: Pedestal.
   3. Housing: Satin aluminum.
   4. Device Plate: Stainless steel.
   5. Configuration: One, duplex.

2.6 PLUGS

The contractor shall furnish suitable plugs with equipment furnished under the respective contract. Plugs shall be black rubber or plastic. For waterproof receptacle, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided provided with clamping nuts and stuffing gland cable outlets.

2.7 PROCESS INTRUMENTS

A. Manufacturers:
   1. Crouse-Hinds
   2. Appleton

B. The contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument) to disconnect the 120 VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch with MT overload protection. For Hazardous locations, the device shall be a front operated general use snap switch mounted in an EFS enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that floor boxes are adjusted properly.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

E. Verify that openings in access floor are in proper locations.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

J. Install protective rings on active flush cover service fittings.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches (1.2 m) above finished floor.

B. Install convenience receptacle 18 inches (450 mm) above finished floor.

C. Install convenience receptacle 6 inches (150 mm) above counter.

D. Install dimmer 48 inches (1.2 m) above finished floor.

E. Install telephone jack 18 inches (450 mm) above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches (1.4 m) above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches (1.2 m) above finished floor.

3.5 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01650.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

Adjust devices and wall plates to be flush and level.

3.7 CLEANING

Clean exposed surfaces to remove splatters and restore finish.

3.8 CIRCUTING

Convenience receptacles shall be grouped on circuits separate from lighting circuits. A maximum of eight (8) convince outlets are permitted per 20A, 120V circuit

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

The contractor shall furnish and install all switches and receptacles for lighting and miscellaneous power applications on the type and at the locations as specified herein and as shown on the electrical drawings.

1.2 SECTION INCLUDES

A. Wall switches.

B. Receptacles.

C. Poke-through service fittings.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

B. Manufacturer's Installation Instructions.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Provide products listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.5 RELATED SECTIONS

A. Section 16100 – Basic Materials and Methods

B. Section 16123 – Building Wire and Cable

C. Section 16510 – Interior Luminaires

D. Section 16160 – Panelboards

E. Section 16520 – Exterior Luminaires

1.6 REFERENCES

A. NECA 1 - Standard Practices for Good Workmanship in Electrical Contracting; National Electrical Contractors Association; 2006.

B. NEMA WD 1 - General Color Requirements for Wiring Devices; National Electrical Manufacturers Association; 1999 (R 2005).

C. NEMA WD 6 - Wiring Device -- Dimensional Requirements; National Electrical Manufacturers Association; 2002.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

1.7 SUPPLIES & SPARE PARTS

A. The contactor shall furnish 10% (minimum of 1) spare each recepticle, switch and plug furnished and installed for this project.

B. Spare parts lists, included with shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

C. Parts shall be completely identified with a numerical system to facilitate part inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size shall have the same number

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Cooper Wiring Devices; www.cooperwiringdevices.com.

B. GE Industrial; www.geindustrial.com.

C. Leviton Manufacturing, Inc; www.leviton.com.

2.2 WALL SWITCHES

A. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: Ivory plastic with toggle handle.
   2. Indicator Light: Lighted handle type switch; red handle.
   3. Locator Light: Lighted handle type switch; red color handle.
   4. Ratings:
      a. Voltage: 120 volts, AC.
      b. Current: 20 amperes.

B. Switch Types: Single pole, double pole, and 3-way.

2.3 RECEPTACLES

A. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
   1. Device Body: Ivory plastic.
   2. Configuration: NEMA WD 6, type as specified and indicated.

B. Convenience Receptacles: Type 5 – 20R NEMA, 20Amps.

C. Single Convenience Receptacles.

D. Duplex Convenience Receptacles.

E. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

2.4 WALL PLATES

A. Jumbo Cover Plates: Ivory, smooth plastic.

B. Weatherproof Cover Plates: Gasketed cast metal with hinged.

2.5 POKE-THROUGH FITTINGS

A. Manufacturers:
   1. Hubbell Wiring Devices - Kellems; www.hubbell-wiring.com
   2. Thomas & Betts Corporation; www.tnb.com
   3. The Wiremold Company; www.wiremold.com

B. Poke-Through Fittings: Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
   1. Fire Rating: 3 hours.
   2. Type: Pedestal.
   3. Housing: Satin aluminum.
   4. Device Plate: Stainless steel.
   5. Configuration: One, duplex.

2.6 PLUGS

The contractor shall furnish suitable plugs with equipment furnished under the respective contract. Plugs shall be black rubber or plastic. For waterproof receptacle, the plugs shall be similar in construction to the receptacles and shall be encased in corrosion resistant yellow housing provided provided with clamping nuts and stuffing gland cable outlets.

2.7 PROCESS INTRUMENTS

A. Manufacturers:
   1. Crouse-Hinds
   2. Appleton

B. The contractor shall furnish and install a local disconnect switch at each process instrument (e.g., level transmitter, flow transmitter, analytical instrument) to disconnect the 120 VAC power supply to the instrument. The device shall be a NSSC series manual motor starting switch with MT overload protection. For Hazardous locations, the device shall be a front operated general use snap switch mounted in an EFS enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that outlet boxes are installed at proper height.

B. Verify that wall openings are neatly cut and will be completely covered by wall plates.

C. Verify that floor boxes are adjusted properly.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

E. Verify that openings in access floor are in proper locations.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.

B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

B. Install devices plumb and level.

C. Install switches with OFF position down.

D. Install receptacles with grounding pole on top.

E. Connect wiring device grounding terminal to outlet box with bonding jumper.

F. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

G. Connect wiring devices by wrapping conductor around screw terminal.

H. Use jumbo size plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

J. Install protective rings on active flush cover service fittings.

3.4 INTERFACE WITH OTHER PRODUCTS

A. Install wall switch 48 inches (1.2 m) above finished floor.

B. Install convenience receptacle 18 inches (450 mm) above finished floor.

C. Install convenience receptacle 6 inches (150 mm) above counter.

D. Install dimmer 48 inches (1.2 m) above finished floor.

E. Install telephone jack 18 inches (450 mm) above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches (1.4 m) above finished floor.

G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches (1.2 m) above finished floor.

3.5 FIELD QUALITY CONTROL

A. Perform field inspection, testing, and adjusting in accordance with Section 01650.

B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.

D. Verify that each receptacle device is energized.

E. Test each receptacle device for proper polarity.

F. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

Adjust devices and wall plates to be flush and level.

3.7 CLEANING

Clean exposed surfaces to remove splatters and restore finish.

3.8 CIRCUTING

Convenience receptacles shall be grouped on circuits separate from lighting circuits. A maximum of eight (8) convince outlets are permitted per 20A, 120V circuit

END OF SECTION

SECTION 16150

ELECTRIC MOTORS

PART 1 - GENERAL

1.1 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 electric motors. All electric motors 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.

1.2 SUBMITTALS

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

A. Expected and guaranteed minimum efficiency values and power factor for operation at 100, 75, 50, 25 and 0 percent load.
B. Type of enclosure.
C. Overall dimensions and proposed size and location at terminal junction boxes.
D. Noise level guarantee.
E. Bearing life certificate.
F. Starting characteristics, including torque and lock rotor current.
G. Motor nameplate data.

1.3 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:
    A. NEMA MG 1.
    B. UL 674.

C. UL 1004.

B. Efficiency: High efficiency; guaranteed minimum values determined in accordance with IEEE Standard 112, Test Method B including stray load loss as follows; or as specified in other Divisions:

	------Synchronous RPM------			
HP	3600	1800	1200	900 & less
15 - 49	90%	91%	90%	88%
50 - 99	92	93%	92%	90%
100 & Above	94%	95%	94%	92%

NOTE: PROVIDE THE MANUFACTURER'S HIGHEST AVAILABLE DESIGN FOR MOTORS LESS THAN 15 HORSEPOWER AND FOR MOTORS SPECIFIED WITH SPECIAL TORQUE (NEMA DESIGN C OR D) OR DUTY CYCLE (INTERMITTENT OPERATION).

1.4 QUALITY STANDARDS

A. Motors shall be designed, manufactured and tested in accordance with the latest revisions of the following standards:
   A. NEMA Standards.
   B. IEEE Standards.
   C. ANSI Standards.
   D. UL Standards.

B. Manufacturers offering products that comply with these specifications include:
   A. General Electric.
   B. Reliance.
   C. U. S. Motors.
   D. Or equal.

1.5 PERFORMANCE

Motors shall be adequate for long periods of inactivity and the effects of an atmosphere that is made corrosive by traces of chemicals normally present in a wastewater treatment plant, and environmental conditions existing at the plant site such as high humidity, insects, plant life, fungus, rodents, etc. When motors are to be inactive in excess of 30 days, the Contractor shall maintain the bearings and rotate the shaft twice a month for the duration of the inactive period. The insulation of all drip-proof and weather-protected motors shall be specially designed for use in atmospheres containing moisture and corrosive fumes, which are normally encountered in wastewater treatment plants.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these specifications, unless otherwise indicated:

B. Unless otherwise specified, all AC motors shall be squirrel cage induction type, rated for continuous duty at service conditions specified herein.

C. The connected load (maximum horsepower required) of each motor shall not exceed its nameplate horsepower rating (exclusive of service factor) under any anticipated operating condition. All motors, except on VFD controllers shall have a service factor of 1.15. VFD drive controlled motors shall meet NEMA MG-1, no exceptions.

D. Motors with synchronous speeds of 1,800 rpm or higher shall have full load current not exceeding the values in NEC Table 430-150. Motors with synchronous speeds of 1,200 rpm shall have full load current not exceeding 110 percent of the above values.

E. Motors shall be rated for a 40 degrees C ambient temperature unless specifically indicated otherwise.

F. Motors shall have a grounding terminal in the motor terminal junction box. The bolt which attaches the grounding lug to motor terminal junction box shall not be used for any other purpose (such as mounting the box to the motor).

G. Drip-proof and weather protected motors shall have 316 stainless steel screens over all openings.

H. Motors specified as totally enclosed and rated 5 horsepower or less may be either fan ventilated or nonventilated. Motors specified as totally enclosed and rated over 5 horsepower shall be fan ventilated.

2.2 MOTOR CONDUIT BOXES

A. Conduit boxes shall be NEMA 7 made of cast iron and shall be of adequate size to permit terminating leads. It shall be possible to rotate these boxes in steps of 90 degrees. Conduit box shall be of adequate size and shall have a sufficient number of correct size openings to accept, all required conduits.

B. Torque Classification: Motors shall match the torque requirements of the driven equipment.

2.3 MOTOR EFFICIENCY AND POWER FACTOR

A. Motors shall be NEMA Design B, of the energy efficient type unless otherwise noted. The motor guaranteed minimum efficiency at full load shall not be less than the values shown in Table 1, in Part 1.3 B.

B. The guaranteed minimum efficiency shall be submitted with the shop drawings. Any motor not meeting the minimum efficiency shall be rejected. If the motor is found in the field to be of a lower efficiency than specified, it shall be replaced with a new motor meeting these specification and efficiency requirements.

2.4 MOTORS OPERATED FROM ADJUSTABLE SPEED DRIVE CONTROLLERS

Provide NEMA MG-1 compliant motors with sufficient nameplate rated capacity to drive the specified equipment and to provide the specified margin between system capacity and connected load after any motor derating required to allow for extra heating in the motor due to the harmonic content in the voltage supplied by the controller. The adjustable frequency drive system supplier shall be responsible for a properly sized and completely compatible drive system. For small PWM drives, motor insulation system shall be suitable for volts/per microsecond = 1200 maximum. For large current source drives, motors shall be compatible with the drive.

2.5 RATING

A. Horsepower (HP): As noted. Where no value is noted, match the requirements of the driven equipment.

B. Phase:
   A. Less than ½ HP: Single Phase.
   B. ½ HP and Larger: Three-Phase.

C. Voltage:
   A. Single Phase Motors: 115/230 volt, 1 phase, 60 Hz.
   B. Three-Phase Motors: 460/230 volt, 3 phase, 60 Hz.

D. Speed, Revolutions Per Minute (RPM): As noted. Where no value is noted, match the requirements of the driven equipment.

E. Torque and Starting Current: Exceptions: Provide NEMA design C or D where required by the driven equipment. Unless specifically noted NEMA design A motors are not acceptable.

F. Insulation and Temperature Rise: Except as noted, Class F insulation with temperature rise, measured by resistance, corresponding to the insulation class in accordance with NEMA standards for operation in a 40-degree C ambient. Exception: For motors used with variable frequency drives provide Class F insulation with temperature rise in accordance with Class B limits.

2.6 CONSTRUCTION

A. Enclosure: Totally enclosed fan cooled (TEFC) cast iron frame with stainless steel drain/breather unless otherwise noted.

B. Windings: Copper.

C. Starting: As noted.

D. Multispeed motors: Two winding type unless otherwise noted.

2.7 ACCESSORIES

A. Provide lifting eyes for 182 and larger frame size.

B. Provide normally closed thermostat for winding protection.

C. Nameplate: Permanently affixed and stamped so as to permit recovery of the nameplate data in the event the nameplate is painted over.

2.8 SEVERE DUTY MOTORS

Motor types designated as severe duty shall have the following minimum features as defined by NEMA:

A. Totally enclosed, mill and chemical duty.

B. Cast iron frames and end shields.

C. Stainless steel hardware, drains, breathers and nameplates.

D. Capillary type drains/breathers.

E. Nonsparking, corrosion-resistant fans.

F. Gasketed conduit boxes.

G. Nonhygroscopic epoxy varnish sealed windings.

H. Extra dips and bakes of insulating varnish for moisture protection of windings.

2.9 SEVERE DUTY EXPLOSION PROOF MOTORS

Motor type designated as severe duty explosion proof motor shall have the following features:

A. Corrosion resistant finish.

B. UL listed for explosion-proof motors, in accordance with UL 674 for Class I, Group D hazardous atmosphere.

2.10 MOTOR TYPES

Motor types indicated in the detailed equipment specifications are defined as follows:

Type 1: Horizontal, variable speed, explosion proof motor for Class I, Group D Hazardous Atmosphere. The motor shall have the following modifications:

A. Breather/drain device
B. Frame temperature thermostat, normally closed contact

PART 3 - EXECUTION

3.1 GENERAL

A. All motors shall be designed, manufactured, and tested in accordance with the latest edition of NEMA MG 1. All motors shall be able to start, accelerate, and drive the design load of the driven equipment without exceeding any of the specified design requirements.

B. Finish shall be manufacturer's standard gray or ANSI 61 gray over a primer and rust inhibitor, unless detailed under motor types and in accordance with 09900 Section, Painting.

3.2 INSTALLATION

A. Verify clearances and alignment prior to operation.

B. Lubricate in accordance with the manufacturer's instructions.

C. Check rotation and correct as necessary

END OF SECTION

SECTION 16155

LOW-VOLTAGE COMBINATION MAGNETIC MOTOR STARTERS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install low-voltage combination magnetic motor starters.

B. Related Sections:
1. Section 16000, Electrical Power and Systems.
2. Section 16100, Basic Materials and Methods.
3. Section 16195, Identification for Electrical Systems.
4. Section 16950 Control Circuits and Pilot Devices

1.2 REFERENCES

Standards referenced in this Section are:

A. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.

B. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

Action Submittals: Submit the following:

A. Shop Drawings:
1. Listing of low-voltage combination magnetic motor starters to be furnished, listing for each the installation location, NEMA rating and enclosure size, and equipment to be controlled.
2. Customized wiring diagrams for low-voltage combination magnetic motor starters.

B. Product Data:
Manufacturer's technical information, specifications, and standardized wiring diagrams for low-voltage combination magnetic motor starters proposed.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. Manufacturers: Provide products of one of the following:
   1. Square D Company.
   2. Allen Bradley Company.
   3. General Electric Company.
   4. Cutler-Hammer.
   5. Or equal.

B. Design, fabricate, and test low-voltage combination magnetic motor starters in accordance with NEMA ICS 2 and NEMA 250.

C. General:
   1. Type: Combination type with magnetic-only motor circuit protector with interrupting rating of not less than 65,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Magnetic coil operated, NEMA horsepower rated, with thermal overload protection. Coil shall be rated 120 vac.
   2. Enclosures: Panel enclosures shall be as required for area classifications specified in Section 16010, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.
   3. Functional Type: Full-voltage, single speed, non-reversing, unless otherwise shown or indicated on the Drawings.
   4. Control power transformer fused and grounded on low-voltage (120 vac) side for each starter.
   5. Auxiliary contacts for motor space heaters, remote status signals, and interlocks as shown or indicated on the Drawings and as required.
   6. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with:
      a. Electronic Overload Relays: Relays shall be electronic type, multi-function, adjustable, current sensing type, that include overload, phase-unbalance, phase-loss, and equipment type ground fault in one package.
      b. Each overload relay shall be manual-reset type and include provisions for resetting by an insulating button on front of starter unit door.
      c. Overload relay shall include normally-open auxiliary contact for remote alarm purposes.
      d. Size overload relay for full-load amperes and service factor of actual motors installed.
   7. Pushbuttons, selector switches, pilot lights, and other devices shall be as shown on the Drawings and in accordance with Section 16960, Control Circuits and Pilot Devices.
   8. Provide nameplate identifying equipment controlled in accordance with Section 16195, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

Examine conditions under which Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

General:

A. Install equipment in accordance with the Contract Documents, Laws and Regulations, and manufacturer's installation instructions.

B. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide suitable 1/4-inch spacers so that enclosure is not installed directly against walls. Provide supports to rigidly support equipment reasonably close to motor where no wall or surface capable of supporting equipment exists.

END OF SECTION

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SECTION 16160

PANELBOARDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install panelboards.

B. Related Sections:
1. Section 16000, Electrical Power Systems.
2. Section 16100, Basic Materials and Methods
3. Section 16195, Identification for Electrical Systems.
4. Section 16451, Dry-Type Low-Voltage Distribution Transformers
5. Section 16289, Surge Protective Devices.

1.2 REFERENCES

A. NEMA PB 1, Panelboards.
B. UL 67, Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
Listing of panelboards to be furnished with identification of their proposed location, and all electrical characteristics, including number and rating of branch circuit breakers and enclosure type.
B. Product Data:
Manufacturer's technical information for panelboards proposed for use, including product literature and specifications. Indicate options and features to be provided.

1.4 QUALITY ASSURANCE

Regulatory Requirements; Comply with the following:
NEC Article 408, Switchboards and Panelboards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Packing:
a. Inspect prior to packing to assure that assemblies and components are complete and undamaged.

b. Protect mating connections.
c. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.

2. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in concrete in ample time to prevent delaying the Work. Upon deliver, check materials and equipment for evidence of water that may have entered equipment during transit.

B. Storage and Protection:
Store panelboards in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Panelboards:
1. Manufacturers: Provide products of one of the following:
   a. General Electric Company.
   b. Eaton/Cutler-Hammer.
   c. Schneider Electric/Square D Company.
   d. General Electric
   e. Or equal.
2. Rating: Voltage rating, current rating, number of phases, number of wires and number of poles as shown or indicated on the Drawings.
3. Circuit Breakers: Molded case, bolt-in thermal magnetic type with number of poles and trip ratings as shown or indicated. Where indicated on the Drawings, circuit breakers shall be ground fault circuit interrupting type equipped with solid state sensing and five-milliamp sensitivity.
4. Circuit breakers for 480-volt panelboards shall have minimum interrupting rating of 18,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings. Circuit breakers for other panelboards shall have minimum interrupting rating of 10,000 ampere RMS symmetrical, unless otherwise indicated on the Drawings.
5. Bus Bars: Bus bars shall be 98 percent conductivity copper. Four-wire panelboards shall have solid neutral bar. Each panel shall have ground bus bar.
6. Main: Panelboards shall have main circuit breaker, unless the Drawings specifically indicate main lugs only.
7. Connect branch circuit breakers for sequence phasing.
8. Enclosures: Panel enclosures shall be as required for the area classifications indicated in Sections 16100, Basic Electrical Materials and Methods, unless otherwise indicated on the Drawings.
9. Construction: Code-grade steel, ample gutter space, flush door, flush snap latch and lock. Panelboards shall comply with NEMA PB 1 and UL 67.
10. Trim: Surface or flush as required.

11. Directory: Typed or computer-printed card, with transparent protective cover in frame on back of door giving circuit numbers and area or equipment served.
12. Identification: Identify panelboards in accordance with Section 16195, Identification for Electrical Systems. Identification shall indicate panel number and voltage.
13. Directory of Existing Panelboards: When adding or removing breakers or loads from existing panelboards, provide a new typed or computer-generated directory card, indicating the circuit numbers and equipment served.
14. Provide surge protective device in accordance with Section 16289, Surge Protective Devices, for each panelboard shown or indicated on the Drawings. Surge protective device shall be included and factory-mounted within panelboard by panelboard manufacturer. Surge protective device monitoring and display shall be visible from front of panelboard.

B. Integrated Panelboard and Transformer:
1. Products and Manufacturers: Provide products of one of the following:
   a. Mini-Power Zone by Schneider Electric/Square D Company.
   b. Mini-Power Center by Eaton/Cutler-Hammer.
   c. Panel Tran by Acme Electric Corporation.
   d. Or equal.
2. General: Unit shall consist of encapsulated dry-type transformer, primary and secondary main circuit breakers, and secondary panelboard all in one enclosure.
3. Transformer Rating: Transformer portion shall comply with Section 16451, Dry-type Low-Voltage Distribution Transformers. KVA, primary voltage, secondary voltage, frequency and number of phases shall be as shown or indicated on the Drawings.
4. Branch Circuits: Molded case circuit breakers, plug-in thermal magnetic type with number of poles and trip ratings as shown or indicated on the Drawings.
5. Enclosure: Enclosures shall be as required for the area classifications indicated in Section 16010, General Provisions for Electrical Systems, unless otherwise indicated on the Drawings.

PART 3 – EXECUTION

3.1 INSPECTION

Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Mounting: Install panelboards at locations shown or indicated. Set cabinets so that top branch circuit breaker is not over six feet above the floor.

B. Directory: Complete typewritten or computer-printed directory indicating items controlled by each circuit breaker and the size of feeder serving the panel.

C. Arrange circuits to balance the loads on the panelboards.

D. Identify panelboards in accordance with Section 16195, Identification for Electrical Systems.

E. Install in accordance with Laws and Regulations, manufacturer's recommendations, and the Contract Documents. Verify proper installation prior to energizing panelboards.

END OF SECTION

SECTION 16165

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.

1.2 REFERENCES

A. UL 98, Enclosed and Dead-Front Switches.

B. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

Regulatory Requirements:

A. NEC Article 404, Switches.

B. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
2. Product Data:
   Manufacturer’s technical information for disconnect switches proposed for use.

B. Maintenance Material Submittals: Submit the following:
   Extra Stock Materials:
   Furnish one set of spare fuses for each fused disconnect switch to be installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers: Provide products of one of the following:

A. Square-D Company

B. Cutler-Hammer

C. General Electric Company

D. Siemens

E. Or equal

2.2 MATERIALS

A. Service Disconnect Switches:
1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in “OFF” position and safety handle.
2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
3. For switches connected to VFD’s, provide auxiliary dry contacts to indicate switch position.

B. Single Throw, Circuit Disconnect Switches:
1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick- make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
3. Provide auxiliary dry contacts to indicate switch position. Provide padlock, lockout capability for safety switches intended to serve as safety disconnects for motor and pump station equipment loads.

C. Disconnect Switches for 120-volt, Single-phase Circuits:
Refer to Section 16141, Snap Switches.

D. Enclosures: NEMA rating shall be as required for area classifications specified in Section 16010, General Provisions for Electrical Systems.

E. Identification:
1. Identify enclosures in accordance with Section 16195, Identification for Electrical Systems.
2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Due to Classified are locations certain disconnect switches will not be required since the means of disconnect to meet NEC will be performed at the MCC via approved lockable and tag methods.

B. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.

D. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

END OF SECTION

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SECTION 16165

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.

1.2 REFERENCES

A. UL 98, Enclosed and Dead-Front Switches.

B. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

Regulatory Requirements:

A. NEC Article 404, Switches.

B. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   Listing of each switch to be furnished, including location, rating, and NEMA enclosure type for each.
2. Product Data:
   Manufacturer’s technical information for disconnect switches proposed for use.

B. Maintenance Material Submittals: Submit the following:
   Extra Stock Materials:
   Furnish one set of spare fuses for each fused disconnect switch to be installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers: Provide products of one of the following:

A. Square-D Company

B. Cutler-Hammer

C. General Electric Company

D. Siemens

E. Or equal

2.2 MATERIALS

A. Service Disconnect Switches:
1. Type: Fused, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in “OFF” position and safety handle.
2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
3. For switches connected to VFD’s, provide auxiliary dry contacts to indicate switch position.

B. Single Throw, Circuit Disconnect Switches:
1. Type: Fused or unfused, horsepower rated, heavy-duty, single throw, quick- make, quick-break mechanism, visible blades in the "OFF" position and safety handle.
2. Rating: Voltage and current ratings and number of poles as required for motor or equipment circuits being disconnected. Switches shall bear a UL label and shall comply with the requirements of UL 98, NEMA KS 1 and NEMA 250.
3. Provide auxiliary dry contacts to indicate switch position. Provide padlock, lockout capability for safety switches intended to serve as safety disconnects for motor and pump station equipment loads.

C. Disconnect Switches for 120-volt, Single-phase Circuits:
Refer to Section 16140, Wiring Devices.

D. Enclosures: NEMA rating shall be as required for area classifications specified in Section 16010, General Provisions for Electrical Systems.

E. Identification:
1. Identify enclosures in accordance with Section 16195, Identification for Electrical Systems.
2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Due to Classified are locations certain disconnect switches will not be required since the means of disconnect to meet NEC will be performed at the MCC via approved lockable and tag methods.

B. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

C. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.

D. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

END OF SECTION

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SECTION 16171

LIGHTNING PROTECTION SYSTEM FOR STRUCTURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals shown, specified, and required to furnish and install lightning protection systems for:
1. Sludge Pump Building
2. Sludge Thickeners
3. Sludge Dewatering Building

B. Coordination:
Review installation procedures included under other Sections and coordinate installation of items to be installed with or before lightning protection systems.

C. Related Sections:
Section 16450: Grounding.

1.2 REFERENCES

Standards referenced in this Section are:
A. Lightning Protection Institute (LPI), LPI 175, Standard of Practice.

B. LPI 176, Standard of Materials.

C. NFPA 70, National Electrical Code.

D. NFPA 780, Standard for the Installation of Lightning Protection Systems.

E. UL 96A, Installation Requirements for Lightning Protection Systems.

F. UL 651, Schedule 40 and 80 PVC Conduit.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Lightning Protection System Subcontractor:
Retain services of lightning protection Subcontractor regularly engaged in providing Master Labeled lightning protection systems.
2. Subcontractor shall be LPI-certified Master Installer or Inspector.

3. Subcontractor shall be listed with UL.

B. Component Supply and Compatibility:
   1. Obtain all materials equipment included in this Section regardless of component manufacturer from a single lightning protection system manufacturer.
   2. Lightning protection system manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for specified service conditions and shall be integrated into the overall system by lighting protection system manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      Complete scaled drawings showing proposed routing and layout of lightning protection system with installation details. Drawings shall include equipment connection details and downlead details.
   2. Product Data:
      a. Manufacturer's catalog cuts and technical information.
      b. Technical specifications.

B. Informational Submittals: Submit the following:
   1. Certificates:
      Certificates of LPI code compliance provided by manufacturer, together with UL Master Label certificate or letter of finding.
   2. Field Quality Control Submittals:
      Master Installer or Inspector's final inspection report following installation.
   3. Qualifications Statements:
      Lightning protection system Subcontractor.

1.5 GUARANTEE

Guarantee:
Contractor shall guarantee the work in accordance with the General Conditions.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

System Description:

A. Each lightning protection system shall consist of a complete cable network on the roof or top of structure involving all air terminals, splices, and bonds with cable downleads routed concealed either directly in the building construction or in conduit to ground, and ground

rods all connected together in an appropriate manner and certified by LPI to provide a zone of protection to entire building against lightning strikes, in accordance with NFPA 780.

B. Provide complete, certified lightning protection system. Provide bonding connections and miscellaneous items for complete system.

2.2 MANUFACTURERS

Manufacturers: Provide products of one of the following:

A. Heary Brothers Lightning Protection Company.
B. Thompson Lightning Protection, Inc.
C. Or equal.

2.3 MATERIALS

A. General:
   1. Size materials in accordance with NFPA 780, UL 96A, and LPI 176.
   2. Materials and equipment shall be labeled or listed by UL for use in Master Labeled lightning protection systems. Completed system shall conform to NFPA 70, NFPA 780, LPI 175, LPI 176, and UL96A.
   3. Materials shall comply in weight, size, and composition for class of structure to be protected in accordance with the following:
      a. Use Class I materials for systems on structures not exceeding 75 feet in height.
      b. Use Class II materials for systems on structures exceeding 75 feet above grade.
   4. Materials shall be corrosion-resistant, heavy-duty type. Unless otherwise specified, materials shall be Type 316 stainless steel, copper, or high copper-content bronze castings. Bolts, screws, and hardware shall be Type 316 stainless steel.
   5. On aluminum surfaces, provide materials specified in Part 2.3.A.4, and provide galvanic isolation from the aluminum surfaces.
   6. Provide fittings, mounting bases, couplings, connectors, fasteners, and other system devices required for complete system.

B. Ground Rods: Comply with Section 16450, Grounding .

C. Ground Cables:
   1. Ground cables shall be copper. In connections to aluminum surfaces provide galvanic isolation.
   2. Ground cable stranding, number and size shall be suitable for classification of structure to be protected.
   3. Exposed ground cable shall be corrosion resistant.

D. Air Terminals:
   1. Air terminals shall be stainless steel 5/8-inch diameter and minimum of 18 inches long.
   2. Air terminals shall include a cast bronze point protector, stainless steel adapter, and copper base.

E. Non-Metallic Conduit and Fittings:
   1. Non-metallic conduit shall be Schedule 80 PVC plastic, rated for 90 degrees C, conforming to UL 651.
   2. Non-metallic fittings shall be of same material and manufacturer as base conduit. Provide cement for joining fittings to conduit. Fittings shall be by same manufacturer as base conduit.

PART 3 – EXECUTION

3.1 INSPECTION

Examine the conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install main conductors to provide two-way path from each air terminal horizontally or downward to connections with ground terminals.

B. Install conductors free of excessive splices and sharp bends. Conductor bends shall form an included angle of not less than 90 degrees and shall not have bend radius less than eight inches. Secure conductors to structure at intervals not exceeding three feet.

C. Conceal down conductors where possible in exterior wall construction. Space down conductors at intervals averaging not more than 100 feet around perimeter of structure. Provide at least two down conductors for each protected structure.

D. For structural steel frame construction, down conductors at upper and lower extremities and at intervals not exceeding 200 feet shall be connected to structural steel. Make connections to steel frame with bonding plates having eight square inches of contact, or by exothermic weld connections.

E. Provide air terminals at intervals not exceeding 20 feet along ridges and around perimeter of flat or gently-sloping roofs. Air terminals shall project a minimum of 10 inches above the area protected.

F. Protect flat or gently-sloping roofs exceeding 50 feet in width, by providing additional air terminals at intervals not exceeding 50 feet on flat or gently-sloping area. Locate air terminals within two feet of roof edges and outside corners of protected areas. Air terminal spacing exceeding these dimensions will be allowed if the area protected is within a “zone of protection” from lightning strikes.

G. Provide air terminals for stacks, flues, mechanical equipment, and other objects, having metal thickness less than 3/16-inch and not located within a "zone of protection". Connect objects having metal thickness 3/16-inch or greater to lightning protection system.

H. Do not connect copper equipment to aluminum surfaces, except using bimetal transition fitting. Lead coating is unacceptable for bimetal transition.

I. Install roof penetrations using through-roof assemblies with solid bars and appropriate roof flashing. Conductors shall not pass directly through roof.

J. Grounded metal bodies shall be bonded to the system using bonding connections and fittings. When ground conductors are installed in conduit, conduit shall be non-metallic.

K. Bond building ground systems including electrical, communication, and telephone services and arresters.

L. Bond metal pipes and roof mounted metal structure to the roof ground loop or to downlead cables.

M. Provide ground electrodes for each down conductor dedicated for lightning protection system and bond electrodes to building or structure grounding system. Connect down conductor to ground rod using high-strength, removable ground clamp. Provide bronze ground rod clamp having at least 1.5 inches of contact between rod and conductor, measured parallel to the axis of the rod, at ground test wells.

3.3 FIELD QUALITY CONTROL

Inspection:

A. During installation, lightning protection system shall be inspected by Master Installer or Inspector at several stages during installation in accordance with LPI requirements.
B. Do not conceal system components until inspection has been completed.
C. Upon completion of lightning protection system, arrange for final lightning system inspection and submit final inspection report to ENGINEER. Final lightning system inspection shall be performed by Master Installer or Inspector in accordance with LPI requirements.

END OF SECTION

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SECTION 16175
INSTRUMENT TRANSFORMERS, METERS, SWITCHES AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of accessories for low voltage switchgear, medium voltage motor starters, low voltage motor control assemblies and switch boards. 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.

1.2 SUBMITTALS

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

A. Product data indicating the general features and dimensions of devices.

B. Burden, accuracy class and ratio data for instrument transformers.

C. Operation and maintenance manuals.

1.3 QUALITY ASSURANCE

Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ANSI C37.20.

B. ANSI C39.1.

C. ANSI C57.13.

D. NEMA STD.11.

PART 2 - PRODUCTS

2.1 INSTRUMENT TRANSFORMERS

A. General:

Instrument transformers shall be molded dry-type in accordance with ANSI C57.13. Transformer volt-ampere rating shall be suitable for carrying the specified load without overheating or exceeding the permissible accuracy for the transformer.

B. Potential Transformers:

Potential transformers shall have an ANSI accuracy class of 0.3. They shall be equipped with current limiting fuses.

C. Current transformers:

Current transformers shall be furnished with the specified ratios. Transformers shall be 5 ampere secondary bar or window type with single secondary winding and secondary shorting device. The accuracies shall conform to ANSI C37.20.

2.2 PANEL METERS

All indicating meters shall be 4-½-inch square, semiflush mounted, dusttight switchboard type. Moving elements provided with zero adjustments and the movement shall be taut-band with an accuracy of plus or minus 1 percent of full scale. The case shall be black. The scale shall be white with black markings. The length of the scale shall be greater than 7 inches over a deflection angle of 250 degrees. The meters shall be manufactured in accordance with applicable requirements of ANSI C39.1

2.3 INSTRUMENT SWITCHES

A. Control and instrument switches shall be heavy duty oil tight units rated 20 amperes at 600 volts. Instrument switches shall be provided with contact blocks and positions specified. Switches shall be of the rotary-cam type and contacts shall have positive wiping action of silver-to-silver contact buttons, 5000,000 operation mechanical life. Switches shall be provided with escutcheon plates and pistol-grip handles. Switches shall be General Electric, SBM, Westinghouse, W-2; or equal.

B. Voltmeter and ammeter switches shall have four positions with the escutcheon legend as follows:

Voltmeter	OFF	1-2	2-3	3-1
Ammeter	OFF	Phase A	Phase B	Phase C

2.4 KEY INTERLOCK

Where specified, the key interlock shall consist of two or more identically keyed brass bolt locks. The bolt on the lock shall prevent the operation of the electrical equipment. One brass key shall be provided for each group of identical locks. The key shall be held captive when the lock is positioned to allow equipment operation.

2.5 INDICATING LIGHTS

Switchboard indicating lights shall be register type of the voltage specified. Bulbs shall be telephone type with a slide base.

2.6 NAMEPLATES

Nameplates shall be provided as specified in Section 16050, Paragraph 2.11.

PART 3 - EXECUTION

All accessories and devices shall be installed per the switchgear manufacturer's instructions.

END OF SECTION

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SECTION 16195

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work. All labeling shall be submitted to the Engineer and the City of Atlanta for approval of nomenclature and label characteristic physical and visual properties.

B. Related Sections:
1. Section 16000, Electrical Power and Systems
2. Section 16110, Raceway, Boxes, and Supports.
3. Section 16111, Conduit.
4. Section 16121, Instrumentation and Communication Cable.
5. Section 16123, Building wire and Cable.
6. Section 16140, Wiring Devices.
7. Section 16150, Electric Motors.
8. Section 16165, Disconnect Switches.
9. Section 16515, Adjustable Frequency, Controlled Speed, Drive Systems.
10. Section 16960, Control Circuits and Pilot Devices.

1.2 QUALITY ASSURANCE

Regulatory Requirements: Comply with the following:
A. NEC Article 110, Requirements for Electrical Installation.
B. NEC Article 210, Branch Circuits.
C. NEC Article 215, Feeders.
D. NEC Article 504, Intrinsically Safe Systems.
E. NEC Article 700, Emergency Systems.
F. NEC Article 701, Legally Required Standby Systems.
G. NEC Article 702, Optional Standby Systems.
H. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
I. NFPA 70E, Electrical Safety in the Workplace.

1.3 SUBMITTALS

Action Submittals: Submit the following:

A. Shop Drawings: Submit the following:
   1. Complete description and listing of proposed electrical identification and electrical identification devices for associated equipment or systems.
   2. Conduit and wire identification numbering system and equipment signage.

B. Product Data:
   Manufacturer's literature, cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

C. Electrical Numbering System:
   Refer to section 16000 1.9 for City Standard Electrical Numbering system

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Nameplates:
      a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
      b. Size: As required.
      c. Letter Size: Minimum 3/16-inch.
   2. Legend Plates:
      a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
         Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
      b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:
   1. Provide high voltage signs for equipment operating over 600 volts.
   2. High-Voltage Safety Signs for Outdoor Applications:
      a. Products and Manufacturers: Provide one of the following:
         B-120-45471 by Brady.
         Or equal.
      b. Unless otherwise shown or indicated, high voltage safety signs shall be not less than 10 inches high by 14 inches

wide, of fiberglass reinforced plastic, and shall comply with 40 CFR 1910.145. Signs shall resist fading from exposure to temperature extremes, ultraviolet light, abrasive, and corrosive environments, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT"

c. Mounting hardware shall be Type 316 stainless steel.

3. High-Voltage Safety Signs for Indoor Applications:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-84084 by Brady.
      2) Or equal.
   b. High voltage safety signs for installation on indoor equipment shall be either pressure-sensitive acrylic or vinyl, and shall be not less than 10 inches high by 14 inches wide, shall comply with 40 CFR 1910.145, and shall read, "DANGER – HIGH VOLTAGE – KEEP OUT".
4. Low-Voltage Safety Signs:
   a. Products and Manufacturers: Provide one of the following:
      1) B-302-86060 by Brady.
      2) Or equal.
   b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
5. Low-Voltage Markers:
   a. Products and Manufacturers: Provide one of the following:
      1) CV442xx by Brady.
      2) Or equal.
   b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on white background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.

C. Arc-flash Safety Signs:
   1. Products and Manufacturers: Provide one of the following:
      a. Brady.
      b. Or equal.
   2. Warning signs shall be adhesive-backed polyester.
   3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required." Arc flash warning signs shall indicate the nominal system voltage, available fault current, clearing time of overprotective device(s) based on available fault current, flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.

D. Voltage System Identification Directories:

1. General:
    a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
    b. Directories shall identify all voltage systems within building or structure.
    c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
    d. Colors shall be in accordance with Section 16120, Low Voltage Electrical Power Conductors and Cables.
    e. Example Directory Text:

Voltage System Identification		
System	**A, B, C**	**Neutral**
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

E. Conduit Labels:
1. Products and Manufacturers: Provide one of the following:
    a. B-915 by Brady.
    b. Or equal.
2. Shall be pre-tensioned acrylic/vinyl construction coiled to completely encircle conduit for conduit up through five-inch diameter, or pre-molded to conform to circumference of conduit six-inch diameter and larger.
3. Attach strap-on style for six-inch diameter conduit with stainless steel springs.
4. Shall be blank for use with custom printed labels.
5. Custom Labels:
    a. Shall have black lettering on yellow background.
    b. Shall not contain abbreviations in legend.
    c. Shall be custom printed on continuous tape with permanent adhesive using thermal printer specified below.
6. Approval by ENGINEER is required for any other labeling method.

F. Wire Identification:
1. Heat Shrinkable Wire and Cable Labeling System:
    a. Products and Manufacturers: Provide one of the following:
        1) B-341 PS-xxx-2W by Brady.
        2) Or equal.

b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.

2. Wrap-Around Wire and Cable Labeling System:
   a. Products and Manufacturers: Provide one of the following:
      1) THT-XX-427 by Brady.
      2) Or equal.
   b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.
3. Approval by ENGINEER is required for any other labeling method.

G. Detectable Underground Warning Tape:
1. Products and Manufacturers: Provide one of the following:
   a. Indentoline by Brady.
   b. Or equal.
2. Material: Polyethylene or polyester with detectable metal core and polyester underlaminate.
3. Width: Two inches.
4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.

H. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
2. Wire and Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) TLS2200 by Brady.
      2) Or equal.
   b. Desktop, Products and Manufacturers: Provide one of the following:
      1) 200M by Brady.
      2) Or equal.
3. Cable Markers:
   a. Portable, Products and Manufacturers: Provide one of the following:
      1) Handimark by Brady.
      2) Or equal.
   b. Desktop, Products and Manufacturers: Provide one of the following:
      1) Labelizer PLUS by Brady.
      2) Or equal.

2.2 FABRICATION

Engraved Identification Devices (Nameplates and Legend Plates):
Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER and the City of Atlanta after start-up and testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials. All identification nomenclature shall be pre-approved by the Engineer and the City of Atlanta. In the event of any conflict between the labeling required by this section and labeling indicated in the Instrumentation and Controls, Div. 17 Specifications, obtain clarification and approval of the Engineer and the City before preparing the labels. Any labels provided, resulting in non-observance of this section may result in the request for preparation of a replacement label to be approved by the Engineer and the City, at no additional cost to the City.

B. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
   2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
   3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
   4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
   5. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
   6. Push Buttons:
      a. Provide legend plates for identification of functions.
      b. Provide nameplates for identification of controlled equipment.
      c. Provide red buttons for stop function.
      d. Provide black buttons for other functions.
   7. Pilot Lights:
      a. Provide legend plates for identification of functions.

b. Provide nameplates for identification of controlled equipment.

c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Green	Stopped, Closed
Red	Running, Open
Amber	Alarm
Blue	Power
White	Status

8. Selector Switches:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
9. Panel Mounted Instruments:
   Provide nameplates for identification of function.
10. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
    a. Provide nameplates for identification.
    b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR"s other submittals. Install nameplates with adhesive.
    c. Interior items requiring nameplates include:
       1) Terminal blocks and strips.
       2) Bus bars.
       3) Relays.
       4) Rear of face-mounted items.
       5) Rear of door-mounted items.
       6) Interior mounted items that require identification when mounted externally.
    d. Circuit Breaker Directory:
       Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
11. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:
   1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
      a. Install rigid safety signs using stainless steel fasteners.
      b. Clean surfaces before applying pressure-sensitive signs and markers.

2. Install high voltage safety signs on all equipment doors providing access to uninsulated conductors, including terminal devices, greater than 600 volts.
3. Provide cable tray safety signs on both sides of cable trays at maximum intervals of 20 feet. Install signs on side rails of tray as acceptable to ENGINEER.
    a. Label cable trays that contain conductors greater than 600 volts with cable tray safety signs.
    b. Cable trays that contain conductors greater than 208 volts and less than 600 volts shall be labeled with low voltage safety signs.
    c. Cable trays that contain conductors of 120/208 volts shall be labeled with low voltage markers.
    d. Do not label cable trays that contain only instrument signal cables.
    e. Label cable trays that contain intrinsically safe wiring or cables in accordance with NEC Article 504.
4. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
5. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories
1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. Provide in each electrical room voltage system identification directory mounted on wall or door at each entrance to room.
3. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
    a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
    b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Arc-flash Safety Signs:
1. Provide arc-flash safety signs as required by NEC Article 110.
2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain 480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

F. Conduit Labels:

1. Provide conduits with conduit labels unless otherwise shown or indicated.
2. Do not label flexible conduit.
3. Do not label exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment, where entire length can be seen..
4. Conduit labels shall indicate the following information:
   Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabelled conduits, and in accordance with approved submittals.
5. Conduits that contain intrinsically safe wiring shall have an additional pipe marker provided that has blue letters on white background and reads, "INTRINSICALLY SAFE WIRING".
   Install intrinsically safe pipe markers in accordance with NEC Article 504 along entire installation. Spacing between labels shall not exceed 25 feet.
6. Provide conduit labels at the following locations:
   a. Where each conduit enters and exits walls, ceilings, floors, or slabs.
   b. Where conduit enters or exits junction boxes, cabinets, consoles, panels, or enclosures, except pull boxes and condulet bodies used for pull boxes.
   c. At maximum intervals of 50 feet along length of conduit.
7. Orient conduit labels to be readable.

G. Wire and Cable Identification:
1. Color-coding of insulated conductors shall comply with Section 16123, Building Wire and Cable.
2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
3. Do not provide labels for the following:
   Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
4. Provide wire and cable labels for the following:
   a. New, rerouted, or revised wire or cable.
   b. Insulated conductors.
   c. Wire and cable terminations:
      1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
      2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
         Label individual conductors in a cable after breakout as specified for wires.
   d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.

Label wires or cables within two inches of entrance to conduit.

e. Wire or cable in junction boxes and pull boxes
Label wires or cables within two inches of entrance to conduit.

f. Wire and cable installed in cable tray.
Wire and cable shall have labels at maximum intervals of 20 feet.

g. Wire and cable installed without termination in electrical manholes.
Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.

5. Wire and Cable Identification System:

a. Wire and cable labels shall be imprinted with an identifying designator.
Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.

b. Field Wiring:
Wire or cable designator shall consist of:

1) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.

2) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.

3) Remaining characters shall be alphanumeric and make wire designator unique.

4) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.

c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
New Cabinets, Consoles, Panels, and Enclosures:
Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 17000, Instrumentation and Controls for Process Systems.

6. Modified Cabinets, Consoles, Panels, and Enclosures:
New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.

H. Terminal Strip Labeling:

1. Label panel side of terminal to match panel wire number.
2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

+++ END OF SECTION 16195 +++

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SECTION 16215

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform electrical power distribution system studies.
   2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.
   3. Electrical power distribution system studies shall include the following, as specified in this Section:
      a. Short-circuit study.
      b. Protective device evaluation study.
      c. Protective device coordination study.
      d. Arc flash analysis.

B. Related Sections:
   Section 16195, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
   2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
   3 IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
   4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
   5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
   6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
   7. NFPA 70E, Electrical Safety in the Workplace.
   8. NEC 70, Section 240.87, Arc Energy Reduction.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer:

a. Engage a registered professional engineer with GA Registration legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.
b. Professional engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.
c. Submit qualifications data.
d. Responsibilities include but are not necessarily limited to:
1) Performing or supervising the performance of electrical power distribution system studies and related field services.
2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.
3) Certifying that tests performed and results achieved conform to the Contract Documents.

2. Field Engineer:
a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.
b. Field engineer may be an employee of the protective device equipment manufacturer.

B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Studies:
a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
b. Time current curves for protective devices included within the power system studies.
c. Calculations and results of arc-flash analysis in report format sealed and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
2. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment outage for testing. Submit shutdown requests for each outage in accordance with Owner's Operations.
3. Field Survey Plan: Submit work plan for field survey and data gathering prior to beginning work. Plan shall indicate the schedule of work, time frames for data

collection, and duration that equipment will be temporarily out of service. Submit shutdown requests for each outage in compliance with Owner's Operations.

B. Informational Submittals: Submit the following:
   1. Test Reports:
      a. Results of field testing.
   2. Qualifications Statements:
      a. Professional engineer.
      b. Field engineer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Final settings of protective devices. Submit compilation of final settings for each equipment lineup within 10 days of programming the associated protective devices.
   2. Electronic Files:
      a. Protective Devices:
         1) Settings for all microprocessor-based protective devices.
         2) Software versions used to program the protective devices.
      b. Electrical Power Distribution System Studies:
         1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for OWNER's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
         2) Electronic files submitted for OWNER's use shall become OWNER's property.
         3) Source files for power studies performed under this Section.

1.5 ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

A. General:
   1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study for the Site's electrical distribution system. Perform studies in accordance with IEEE 141, IEEE 242, and IEEE 399.
   2. Studies shall include all portions of high-, medium-, and low-voltage electrical power distribution systems, from the normal and alternate sources of power through low-voltage distribution system. Thoroughly cover in the study normal system operating method, alternate operation, and operations that could result in maximum fault conditions.
   3. Perform a complete study to evaluate both new and existing devices, and include recommendations on required adjustments. Studies shall include both the normal utility supply and standby generator systems.
   4. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.
      a. Preliminary Short-circuit and Coordination Study: Base the evaluation on the worst case operating mode. Base the evaluation on estimated cable lengths, and proposed equipment and protective devices.

b. Final Short-circuit and Coordination Study: Base the evaluation on utility-confirmed contribution. Evaluate the distribution system under each of the various operating modes. Base the evaluation on actual confirmed cable lengths, and installed equipment and protective devices.

5. For circuit breakers with overcurrent device continuous current trip settings rated 1200A or higher, provide arc energy reduction per NEC 70, Section 240.87.

B. Short-circuit Study:
   1. Perform short-circuit evaluation using computer software specifically designed for such use.
   2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
   3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electro-motive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:
   1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
   2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:
   1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
   2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.
   3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium- and low-voltage equipment. Phase and ground overcurrent and phase and ground fault protection shall be included, and settings for other adjustable protective devices.
   4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective

coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.

5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
    a. Representative one-line diagram, legends, and types of protective devices selected.
    b. Power company's relays or fuse characteristics.
    c. Significant motor starting characteristics.
    d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
    e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
    f. Relay taps, time dial and instantaneous trip settings.
    g. Cable damage curves.
    h. Symmetrical and asymmetrical fault currents.
6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc-Flash Analysis:
1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
    a. Bus and protection device name.
    b. Bolted and arcing fault values.
    c. Protective device trip times.
    d. Arc flash boundary, working distance, and incident energy.
    e. Required protective flame-resistant (FR) clothing class.

1.6 STUDY REPORT

A. Summarize results of electrical power distribution system studies in a typed or computer-printed report that includes the following:
1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.
3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
4. Fault current tabulation including definition of terms and guide for interpretation.
5. Tabulation of appropriate tap settings for relay seal-in units.
6. Tabulation of equipment survey information.

B. Electrical power distribution system studies report shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.
B. Prior to performing studies, obtain information pertaining to existing system necessary for performing studies.

3.2 FIELD TESTING

A. Provide protective device field testing in accordance with manufacturers' recommendations. Field testing shall be by CONTRACTOR's field engineer, after submittal of and ENGINEER's acceptance of electrical power distribution system studies. Field testing results shall be documented in a report that shall include final settings of protective devices.
B. Field engineer shall provide necessary tools and equipment and adjust, set, calibrate, and test protective devices. Protective relays and meters in medium- and low-voltage equipment shall be set, adjusted, calibrated, and tested in accordance with manufacturers' recommendations and the coordination study. Provide minor adjustments, repairs, and lubrication necessary for proper operation.
C. Electromechanical protective relays provided in accordance with the Contract Documents shall be set and tested for acceptance. Testing shall include visual and mechanical inspection. Testing shall include overcurrent time and pick-up tests.
D. Solid state and multi-function trip devices shall be set, including required programming necessary for the protection required. Devices shall be checked, configured, and tested for setting and proper operation.

3.3 MAINTENANCE OF OPERATIONS

Field testing may require that certain equipment be temporarily taken out of service. CONTRACTOR shall perform the Work with due regard to the need of OWNER for continuance of operations and in accordance with sequencing required in the Contract Documents, and in accordance with Owner's Operations. Submit testing procedures and schedules and obtain acceptance by ENGINEER prior to starting testing and related Work.

3.4 INSTALLATION

Provide personnel protective equipment labels in accordance with Section 16195, Identification for Electrical Systems.

Supplier Services: Provide training for OWNER's operation and maintenance personnel in personnel protection equipment. Provide at least eight hours of training, in accordance with General Conditions for Instruction of Operations and Maintenance Personnel.

END OF SECTION

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SECTION 16289

SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).
2. SPDs furnished under this Section shall be ANSI/UL 1449 3rd Edition Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

B. Related Sections:
1. Section 16000, Electrical Power and Systems.
2. Section 16160, Panelboards.
3. Section 16450, Grounding.
4. Section 16481, Low Voltage Motor Control Centers.

1.2 REFERENCES

Standards referenced in this Section are:
A. ANSI/UL 1449 3rd Edition, Surge Protective Devices.
B. IEEE C62.11, Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)
C. IEEE C62.41, Recommended Practice on Surge Voltages in Low-voltage AC Power Circuits.
D. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1,000 V and Less) AC Power Circuits.
E. UL 1283, Electromagnetic Interference Filters.

1.3 QUALITY ASSURANCE

A. Qualifications:
Manufacturer: Shall have at least five years experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.

2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

C. Regulatory Requirements: Comply with the following:
1. NEC 110.9, Requirements for Electrical Installations, Interrupting Rating.
2. NEC 240.21, Overcurrent Protection, Location in Circuit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.
b. Components list and nameplate schedule.
c. Summary sheets with schedules of equipment.
2. Product Data:
a. Manufacturer’s technical information, including catalog information.
b. Manufacturer's technical specifications with assembly and component ratings.

B. Informational Submittals: Submit the following:
1. Certifications:
Certification that SPD devices comply with standards referenced in this Section.
2. Source Quality Control Submittals:
Report of results of testing and inspections performed at manufacturer’s shop.
3. Supplier Reports:
Submit written report of results of each visit to Site by Supplier’s service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.
4. Qualifications Statements:
Manufacture, when requested by ENGINEER.

C. Closeout Submittals: Submit the Following
1. Operations and Maintenance Data:
Include acceptable test reports, maintenance data and schedules, description of operation, wiring diagrams, and list of spare parts recommended for one year of operation with current price list.

2. Warranty Documentation: Submit example warranty at time of shipment of the equipment. Include final warranty accepted by ENGINEER in the operations and maintenance manual for the equipment.

1.5 DELIVERY, STORAGE, AND HANDLING.

A. Delivery:
Upon delivery, check for evidence of water that may have entered equipment during transit.

B. Storage:
1. Store SPD equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.
2. Protect equipment from corrosion and deterioration.

1.6 WARRANTY

Contractor shall warrantee the work in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

Manufacturers: Provide equipment of one of the following:
A. General Electric.
B. Schneider Electric/Square-D Company.
C. Eaton/Cutler-Hammer.
D. Or equal.

2.2 EQUIPMENT

A. General:
1. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.
2. SPD shall comply with requirements of the following:
a. ANSI/UL 1449.
b. UL 1283.
c. IEEE C62.11, IEEE C62.41 and IEEE C62.45.
3. SPD shall be suitable for operation under the following environmental conditions:
a. Relative Humidity: Zero to 95 percent, non-condensing.
b. Frequency: 47 to 63 Hertz.
c. Temperature: Zero to 149 degrees F.

4. SPD operating voltage and IEEE C62.41 and IEEE C62.45 Category A, B, and C application environments shall be suitable for the associated SPD location(s) shown or indicated on the Drawings.
5. SPD shall be suitable for internal and external mounting. Where shown on the Drawings, SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
   a. Section 16411, Motor Control Centers.
   b. Section 16160, Panelboards.

B. SPD shall include a surge suppression path for each mode as required for the system configuration shown on the Drawings. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:
1. Line-to-line.
2. Line-to-neutral.
3. Line-to-ground.
4. Neutral-to-ground.

C. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

D. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115 percent of nominal system operating voltage.

E. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	208Y/120	480Y/277
L-N,L-G, N-G	800	1200
L-L	1200	2000

F. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	Application	Per Phase	Per Mode
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

2.3 ACCESSORIES

Provide SPD equipped with the following accessories:

A. Surge counter with display for indicating the number of surges detected.

B. LED indicators for monitoring device status.

C. Audible alarm and silence switch for indicating an inoperative condition.

D. Dry contacts, “Form C”, for remote annunciation of unit status.

E. Indicators, counter, alarm, and silence switch shall be visible and accessible from front of the SPD. When SPD is integral to switchgear, motor control center, panelboard, or other equipment, indicators, counter, alarm, and silence switch shall be visible and accessible from front of the equipment in which the SPD is installed.

F. Enclosure for each externally-mounted SPD: NEMA rating shall be as required for area classifications specified in Section 16010, General Provisions for Electrical Systems.

2.4 SOURCE QUALITY CONTROL

Perform manufacturer’s standard factory tests on equipment. Tests shall be in accordance with IEEE C62.45 and ANSI/UL 1449.

PART 3 - EXECUTION

3.1 INSPECTION

Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install SPD at locations shown on the Drawings in accordance with equipment manufacturer’s recommendations, Laws, and Regulations, and the Contract Documents. When not shown on drawings, power SPD for major equipment and panels shall be mounted external to the equipment protected. Follow manufacturer recommendations for minimum distance to protected equipment.

B. Conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

SECTION 16340
MEDIUM-VOLTAGE METAL CLAD SWITCHGEAR

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install medium-voltage metal clad switchgear, circuit breaker type.

B. Related Sections:
1. Section 16195, Identification for Electrical Systems.
2. Section 16215, Electrical Power Distribution System Studies.

1.2 REFERENCES
Standards referenced in this Section are:
A. ANSI/IEEE C37.010, Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis (includes supplements ANSI/IEEE C37.010b and ANSI/IEEE C37.010d).
B. IEEE C37.04, Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
C. ANSI/IEEE C37.06, AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required Capabilities.
D. IEEE C37.09, Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
E. IEEE C37.11, Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
F. ANSI C37.20.2, Standard for Metal-clad Switchgear.
G. IEEE C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
H. ANSI/NEMA C37.55, Medium-Voltage Metal-Clad Assemblies - Conformance Test Procedures.
I. IEEE C57.13, Performance and Test Requirements for Instrument Transformers of a Nominal System Voltage of 115 kv and Above.
J. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
K. ISO 9000, Quality Management Systems – Fundamentals and Vocabulary.
L. ISO 9001, Quality Management Systems – Requirements.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
    a. Manufacturer shall have experience producing substantially similar equipment to that specified, and shall be able to document at least five installations in satisfactory operation.
    b. For equipment specified, manufacturer shall be ISO 9000 and ISO 9001 certified.

2. Manufacturer Testing:
    a. Manufacturer's factory Internal and Service testing per ANSI/NETA.
    b. Test Equipment, Calibration and Reporting: Test equipment, instrument calibration, and test reports shall be in accordance with ANSI/NETA ATS.

B. Seismic Requirements: The Work shall comply with seismic zone 1 requirements in accordance with Section for Vibration, Seismic and Wind Controls.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
    a. Outline, summary sheets and equipment schedules.
    b. Unit control schematics and elementary wiring diagrams showing numbered terminal points and interconnections to other units.
    c. One-line diagrams.
    d. Dimensional information, including front elevation and floor plans.
    e. Construction details of enclosures with conduit entry locations and connection details between assemblies.
    f. Key interlock scheme and sequence of operation.
2. Product Data:
    a. Technical specifications with assembly and component ratings.
    b. Time current curves for protective devices.
    c. Catalog cuts, components list, and nameplate schedule.
3. Testing Plans: Thirty days in advance of actual factory and field testing, submit proposed testing procedures, methods and apparatus.

B. Informational Submittals: Submit the following:
1. Design Data: Battery sizing calculations.
2. Manufacturer's Instructions: Instructions for handling, storing, installing, and start-up.
3. Source Quality Control Submittals: Reports of completed factory testing, including testing procedures used and testing results.
4. Field Quality Control Submittals: Reports of completed field testing, including testing procedures used and testing results.
5. Manufacturer's Reports: Reports of visits to Site by manufacturer's technical service representative, including descriptions of problems encountered and problem resolutions implemented.
6. Qualifications Statements:
    a. Manufacturer's qualifications and experience when requested by ENGINEER, including previous similar installations.

b. Manufacturers internal testing qualifications.

C: Closeout Submittals: Submit the following:
Operations and Maintenance Data:

A. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
B. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
C. Submit operation and maintenance manuals in accordance with Section 01730, Operations and Maintenance Data.

D. Maintenance Material Submittals: Furnish the following:

Spare Parts and Maintenance Materials:

A. Furnish, tag, and box for shipment and long term storage the following spare parts and special tools for each medium-voltage metal clad switchgear lineup:

Item	Quantity per Medium-Voltage Metal Clad Switchgear Lineup
1) Circuit breakers, size per Drawings	In accordance with the Drawings
2) Manual ground and test device	One
3) Handle tool for manually charging breaker closing spring and manually opening shutter	One
4) Levering cranks for moving the breakers between test and connected positions	Two
5) Test jumper for operating the breaker while out of its compartment	One
6) Breaker lifting devices or mechanisms for lifting breaker on or off compartment	One complete set
7) Rail clamps for clamping breaker on extended rails	One complete set
8) Protective relay	One per each type used
9) Control relay	Two of each type used
10) Pilot light	Two per ten of each type used
11) Fuses	Two set of each type and size used

B. Furnish list of additional recommended spare parts for operating period of one year. Describe each part, quantity recommended, and current unit price.

C. Package spare parts in suitable containers bearing labels clearly indicating contents and equipment with which they are to be used.
D. Provide single transport dolly for transporting circuit breaker outside its compartment. Dolly shall be suitable for transporting circuit breakers from medium-voltage metal clad switchgear provided under this Contract.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping sections shall be designed to be shipped by truck, rail, or ship. Indoor sections shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

B. Medium-voltage metal clad switchgear shall be equipped to be handled by crane. Where cranes are not available switchgear shall be suitable for placement on rollers using jacks to raise and lower the groups.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide medium-voltage metal clad switchgear in accordance with arrangement indicated on Drawings. Switchgear shall be a metal-enclosed assembly of breaker housings, auxiliary housings, and vacuum circuit breakers assembled with individual vertical steel sections bolted together to form a rigid metal-clad assembly.

B. Performance Criteria: Ratings for medium-voltage metal clad switchgear lineup shall be:
1. 4.16 KV nominal.
2. 15 KV maximum design.
3. 60 KV BIL.
4. 1,200 amperes, main bus, continuous.
5. Short circuit ratings:
   a. 250 MVA class nominal three-phase.
   b. 29 KA three-phase RMS symmetrical current at 4.16 KV.
6. Short circuit current capability of breakers shall be in accordance with ANSI/IEEE C37.06.

2.2 MANUFACTURERS

Manufacturer: Provide products of one of the following:
A. General Electric.
B. Cutler-Hammer.
C. Schneider-Square D
D. Or equal.

2.3 CONSTRUCTION

A. Design, construct, and test medium-voltage metal clad switchgear in accordance with the following standards.
ANSI/IEEE C37.010, IEEE C37.04, IEEE C37.09, IEEE C37.11, ANSI C37.20.2 and ANSI/NEMA C37.55.

B. Medium-voltage metal clad switchgear structure shall be metal-enclosed, dead front, free standing, dust resistant, and fabricated of code gauge steel.

C. Buses:
1. Buses shall be copper with tin plated connections. Ground bus shall be 1/4-inch by 2-inch minimum. Power and ground buses shall run the length of the medium-voltage metal clad switchgear.
2. Power bus supports, bus, and interconnections shall withstand stresses associated with short-circuit currents up through the close and latch rating of circuit breakers. Bus work momentary rating shall equal or exceed short circuit rating of circuit breakers.
3. Main bus shall have epoxy, flame retardant, track-resistant insulation. Bus supports between units shall be glass polyester.
4. Bus joints shall be plated, bolted, and insulated with boots.
5. Ground bus shall be tin plated and shall have a 4/0 connector at each end.

D. Structure:
1. Each vertical section shall be capable of stacking breakers two high and auxiliaries four high.
2. Each vertical steel unit shall be of a self-contained and self-supported structure having one or more individual breaker or instrument compartments, a centralized bus compartment, and a rear cabling compartment segregated from the bus sections. Equip rear compartments with hinged access doors secured with a minimum of three bolts each and captured nuts.
3. Equip each individual breaker compartment to house removable breaker assembly. Breaker levering mechanism shall be cell mounted and include all interlocks to render breaker trip-free during levering. A ground contact shall ground the breaker between operating and test positions. Recess circuit breaker stationary primary disconnecting contacts within insulating tubes. Grounded safety shutters shall automatically cover stationary contacts when breaker element is withdrawn from the connected position. Provide draw-out type assembly with a mechanical interlock to prevent moving breaker into or out of operating position unless breaker is tripped. Breaker rails shall allow withdrawal of breaker for inspection.
4. Cable compartment shall be at rear of breaker compartment. Rear cover sheet shall be bolted to the frame and be easily removed by removing bolts. Compartment shall have ample space for cables, stress cones, potheads, current transformers, and other related components. Provide barriers to isolate circuit terminations when two breakers are in the same vertical section.
5. Enclose main buses in a metal compartment with removable covers for accessibility. Design end bus compartments to allow future extension of bus.
6. Auxiliary compartments shall be used to mount potential transformers, control power transformers, and miscellaneous devices. Where rollout trays are provided to mount

potential or control power transformers, equip movable carriage with primary and secondary disconnecting devices, grounding devices, and a safety barrier.

7. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

2.4 CIRCUIT BREAKERS AND DEVICES

A. Circuit Breakers:

1. Power breakers shall be vacuum, draw-out type, three-pole, 60 Hertz, with voltage and interrupting class as specified, and continuous current ratings in accordance with the Drawings.
2. Operation: Breaker shall be electrically operated by a motor-charged, spring type stored energy mechanism. Mechanism shall be front accessible and be charged by an electric motor. Include provisions to charge mechanism by a manual handle.
3. Breaker control voltage shall be 120 volt DC close and trip.
4. Circuit breakers shall have interlocks as follows:
   a. Trip or prevent closing of breaker upon insertion or removal from housing.
   b. To discharge stored energy mechanism upon insertion or removal from housing.
5. Circuit breakers shall have mechanical indicators for:
   a. Positive indication of breaker open or closed position.
   b. Positive indication of breaker closing spring charged or discharged.
   c. Positive indication of breaker test, connect, or disconnect position.
6. Breaker shall be horizontal draw-out type capable of being withdrawn on wheels on rails with provisions for padlocking in test and disconnect position. Primary disconnecting contacts shall be silver-plated copper. Each breaker shall contain three vacuum interrupters mounted separately. Breaker front panel shall be removable for inspection. Secondary contacts shall be silver-plated and automatically engage in breaker operating position.
7. Provide circuit breakers with control devices for operation and indication. Devices shall include fuses, auxiliary contacts, and other components as required for open-close-trip operation. Each circuit breaker compartment door shall include open-close status lights. Mount circuit breaker control switches remotely, on breaker control panel specified.
8. Termination Lugs: Incoming line and feeder cable lugs shall be two-hole compression copper terminals suitable for cables indicated on Drawings.

B. Instrument Transformers:

1. Current transformers and potential transformers quantities and ratios shall be in accordance with the Drawings.
2. Current transformers shall be window type, 600V, 10KV BIL suitable for relaying and metering medium-voltage metal clad switchgear applications and mounting in the breaker compartment. Circuit transformers shall be accessible for inspection and maintenance and allow addition or changing without removing high voltage insulated connections.

3. Current transformers shall have a continuous thermal current rating factor of 1.33 or greater at 30 degrees C ambient. Current transformers shall have a short time thermal rating of 75 times or greater rated current for one second. Mechanical ratings shall equal the close and latch rating of circuit breakers.
4. Current transformers accuracy class shall be in accordance with IEEE C57.13, relaying accuracy shall be in accordance with:

Transformer Rate	Minimum Relaying Accuracy Class
100/5	C10
150/5 to 300/5	C20
400/5 and 500/5	C50
600/5 and 1000/5	C100
1200/5 to 3000/5	C200

5. Current transformers used for differential protection shall have the same ratio, same secondary excitation characteristics, and same manufacturer type.
6. Potential transformers shall be draw-out type in rollout carriages and equipped with current limiting fuses both on primary and secondary sides. Potential transformers shall be automatically disconnected from the power source as access door is opened or carriage withdrawn. Locate potential transformers and fuses either in auxiliary compartment of the vertical section or in a separate auxiliary unit as required.
7. Insulate potential transformers for full voltage and BIL rating of medium-voltage metal clad switchgear. Potential transformers shall have a 0.3 percent ANSI accuracy classification and a thermal rating at 30 degrees C ambient of 750VA for 5 KV applications and 1500VA for applications above.
8. Current and potential transformer secondaries shall be grounded. Secondary leads of each current transformer shall be wired directly to shorting type terminal blocks.

C. Protective Relays:
Over-current Protective Device: Where indicated on Drawings, provide each circuit with the following multi-function over-current protective device.
    1. Over-current protective device shall be a multi-function trip unit that monitors phase and ground currents and makes trip decisions from operator selectable protective functions. Unit shall have a front panel and display for monitoring and programming functions.
    2. Protective features shall include:
        a. True RMS sensing of each phase and ground current.
        b. Phase and ground over current protection with long delay setting and time, short delay setting, and time and instantaneous setting.
        c. Four selectable long time curve slopes.
        d. Independent instantaneous and time over-current trip contacts.
        e. Phase and ground zone selective interlocking.
    3. Display functions shall include:
        a. Individual phase currents.
        b. Ground current.
        c. Magnitude and phase of trip current.

d. Peak current each phase and ground since last reset.
e. Current transformer ratio.
f. Cause of trip.

4. Equip over-current protective device with the following output capability:
   a. Dry contacts for trip, trip alarm, and protection off.
   b. Communication capability via RS-485, ModBus RTU Protocol.

D. Auxiliary Components:

1. Control Wiring: Control wiring shall be stranded, tinned copper, Type SIS, rated 600 volts. Terminate wire with crimp type insulated spade terminals or non-insulated ring terminals. Armor or enclose control wires in grounded metal troughs where they pass through primary compartments.
2. Control Power Source, DC: Provide medium-voltage metal clad switchgear with a 125 V dc control power source consisting of a storage battery and associated charger. Battery system shall be in accordance with requirements specified in this Section.
3. Provide UPS for Multi-function Relay and switchgear control backup power
4. Key Interlocking: Provide Main-tie-Main CB with key interlock systems as required for interlocking schemes depicted on Drawings. Each system shall be complete with all necessary keys and locks for the schemes indicated.
5. Circuit Breaker Control Panel: Provide medium-voltage metal clad switchgear with a NEMA 12 circuit breaker control panel for manual control of circuit breakers. Provide control panel with an Open-Trip control switch and Open and Close status lights for each circuit breaker.
6. Remote Breaker Racking Device: Equip each breaker compartment door for breaker racking. The 120-volt racking mechanism shall be mounted and remotely operated without opening compartment door. Equip mechanism with a motor, cord, and plug attachment, and a control switch with control cord 20 feet long and plug.
6. Lightning arrestors, station class, 5 KV on line side of medium-voltage metal clad switchgear or incoming breaker.

2.5 MAIN METERING DEVICE

Provide a main meter device as shown on Drawings.

A. Microprocessor-based monitoring device shall provide complete electrical metering in one package.

B. Mount monitoring device on the compartment door to allow operator access to meter menu and display.

C. Device shall include trend analysis, event logging, and recording. Device shall include the following direct reading metered values:

a.	Volts:	0.2 percent accuracy.
b.	Amperes:	0.2 percent accuracy
c.	Watts, Vars and VA:	0.5 percent accuracy
d.	Power Factor:	1.0 percent accuracy
e.	Frequency:	0.05 percent accuracy
f.	Watt, and VA Hours:	0.5 percent accuracy
g.	Var Hours:	1.0 percent accuracy

h. Watt, Var and VA Demand: 0.4 percent accuracy
i. THD-Voltage: 50th harmonic
j. THD-Current: 50th harmonic
k. Individual Ampere Harmonics: 50th harmonic
l. Individual Voltage Harmonics: 50th harmonic

D. Metering device shall have the following:
   a. Trend analysis that shall display minimum and maximum values for each metered parameter with date and time of each occurrence.
   b. Input range of device shall accommodate external current transformers with ranges from 100/5 to 5000/5 and potential transformers from a ratio of 120:120 to 500,000:120.
   c. Alarm contacts rated five amps at 120 VAC.
   d. Three analog outputs programmable to reflect each metered parameter, except kilowatt hours and kilovar hours.
   e. Communication capability via RS-485, Modbus RTU Protocol.

E. Draw control power from monitored incoming AC line. Device shall have non-volatile memory and shall not require battery backup. During power failure, device shall retain preset parameters.\

2.6 WALK-IN ENCLOSURE

Provide walk in enclosure when shown in the drawings for outdoor switchgear

A. Entire medium-voltage metal clad switchgear shall be enclosed in outdoor enclosure assembled as a gasketed, ventilated, weatherproof, rodent-proof, walk-in type structure, rated NEMA 3R, installed at location shown on Drawings.

B. Enclosure material shall be steel, 18 gauge minimum. Enclosure shall be equipped with rear doors for access to terminations and include nameplates for equipment identification. Nameplates shall be in accordance with Section 16195, Identification for Electrical Systems.

C. Equip enclosure with the following:
   1. Insulation, including top and sides.
   2. Ventilation by an exhaust fan and louvered openings provided with suitable screen or grill to retard entrance of dust, rodents, and foreign material.
   3. Key lockable doors with panic hardware.
   4. Space heaters and thermostat for each medium-voltage metal clad switchgear compartment. Heaters shall be rated 240 volt and operated at 120 volt.
   5. Convenience receptacles, fluorescent lights, outdoor weatherproof lights, and three-way switches.
   6. Thermostatically controlled electric heaters, one at each entrance.
   7. Ancillary power transformer, with primary and secondary circuit protection, distribution panel board, and thermostatically controlled electric space heater. Locate components to be readily accessible within medium-voltage metal clad switchgear.

8. Equipment in walk-in enclosure shall be pre-wired at factory. Equip panel board with circuits required for medium-voltage metal clad switchgear accessories.

D. Coatings for enclosures are specified in this Section.

2.7 BATTERY SYSTEM

A. Provide a battery system, including battery and charger, to operate breaker control circuits for medium-voltage metal clad switchgear shown on Drawings.

B. Battery system design shall comply with the following:
   1. Voltage: 125 volts dc.
   2. Operating Temperature Range: -20 to 100 degrees F.
   3. Continuous Load: In accordance with medium-voltage metal clad switchgear manufacturer for eight hours minimum.
   4. Ten circuit breaker operations singly in sequence with closing, charging, and tripping ratings in accordance with medium-voltage metal clad switchgear manufacturer.
   5. Ten percent design margin and 125 percent aging factor.

C. Battery:
   1. Battery shall consist of maintenance-free, nickel cadmium cells. Battery shall have a minimum fully charged rated capacity and minimum one minute discharge rate to 1.2 volts per cell as required by medium-voltage metal clad switchgear manufacturer.
   2. Cells shall be of pocket plate construction, having active material contained within pockets of perforated steel strips. Mount battery cell adjacent to medium-voltage metal clad switchgear within single or double tier racks.
   3. Join battery cells in series with nickel-plated solid copper connectors and nickel-plated hardware. Flexible inter-step connectors shall be of insulated copper welding cable with plated copper terminals securely crimped to the ends. Size cable to accommodate maximum battery load.
   4. Battery rack rails, frames, and braces shall be steel and epoxy powder coated with alkali-resistant paint. Battery rack hardware shall be stainless steel. Rack rails shall be covered with plastic insulators to insulate them from the cells.

D. Charger:
   1. Charger shall be full wave rectifier type, using transistor controlled magnetic amplifier technology to provide continuous taper charging. Hermetically-sealed silicon diode rectifiers shall be used for rectification.
   2. Charger shall be listed by Underwriters laboratories and have UL label attached.
   3. Ambient Temperature and Relative Humidity Range: -20 to 122 degrees F, with relative humidity from zero to 95 percent.
   4. Charger shall be convection cooled, designed for wall or floor mounting, and provide easy access to all electrical components for in-service troubleshooting and repair. Enclosure shall be steel and finish-painted with gray baked enamel.

5. Charger shall be 120 volt operated suitable for batteries provided and steady load of medium-voltage metal clad switchgear. Charger shall be equipped with dc ammeter and voltmeter, ground detection lights, and low and high dc alarm relays.

E. Battery system shall be supplied by medium-voltage metal clad switchgear manufacturer.

2.8 IDENTIFICATION

Provide control wiring and internal device identification for each compartment, including:

A. Identify all control conductors with permanent type wire markers. Identify each wire by a unique number and attached to wire at each termination point.

B. Identify all control devices with permanent type markers. Identify each device by a unique number and attached to each device.

C. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.9 FINISHING

Thoroughly clean medium-voltage metal clad switchgear metal surfaces, provide surface preparation in accordance with paint manufacturer's recommendations, and provide one coat of standard primer. Surfaces located indoors shall be given one shop coats of standard finish. Provide exterior surfaces located outdoors two shop coats of standard finish. Color of finishing coats shall be ANSI No. 61, "light gray".

2.10 SOURCE QUALITY CONTROL

Perform factory tests on equipment prior to shipment, consisting of manufacturer's standard tests, which shall include:

A. Production tests on circuit breakers, medium-voltage metal clad switchgear assembly, and components in accordance with ANSI C37. 09.

B. Physical inspection of all components, and wiring checks.

C. Breaker operation, device functional tests, and sequencing of control circuits.

D. Primary, control, and secondary wiring dielectric tests.

PART 3 – EXECUTION

3.1 INSPECTION

Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install equipment on concrete bases in accordance with manufacturer's recommendations and instructions.

B. Terminations and Appurtenances:
   1. Install terminations, lugs, and required appurtenances to properly terminate power supplies.
   2. Install control wiring terminations and appurtenances necessary to complete the installation of control and monitoring devices.

3.3 FIELD QUALITY CONTROL

A. Site Tests
   1. Provide field testing and inspection of medium-voltage metal clad switchgear. After installation, inspect, adjust, and test switchgear. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Manufacturer's representative shall inform OWNER and ENGINEER when equipment has been correctly installed. Do not energize equipment without permission of OWNER.
   2. Perform the following tests and checks before energizing equipment:
      a. Verify proper installation of medium-voltage metal clad switchgear and protective device settings.
      b. Inspect all mechanical and electrical interlocks and breakers for proper operation.
      c. Check tightness of bolted connections. Torque to manufacturer's requirements.
      d. Measure insulation resistance of each bus section phase-to-phase and phase-to-ground.
      e. Measure insulation resistance of each circuit breaker pole-to-pole and from pole-to-ground.
      f. Perform other tests and adjustments recommended by equipment manufacturer.
   3. Qualified, factory-trained service representative, from protective relay manufacturer shall perform calibration, settings, and programming of actual protective devices provided.
   4. Provide manufacturer testing of medium-voltage metal clad switchgear. Inspect and test each switchgear. Testing and inspection shall be performed by manufacturer, after completion of testing specified in Paragraph 3.3.A 1 of this Section.
      a. Visual and Mechanical Inspection: Inspect each medium-voltage metal clad switchgear in accordance with ANSI/NETA ATS, including:
         1) Inspect for physical, electrical, and mechanical condition.
         2) Check for proper anchorage, required area clearances, physical damage, and proper alignment.
         3) Inspect all bolted connections for high resistance.
         4) Check electrical and mechanical interlock systems for proper operation.
         5) Perform mechanical operational tests on each circuit breaker and its operating mechanism.

6) Measure and adjust as required circuit breaker mounting provisions.
7) Inspect protective relay components, check for freedom of movement, proper travel and alignment, and tightness of mounting hardware and plugs.
8) Clean entire switchgear.

b. Electrical Tests: Perform electrical testing of each medium-voltage metal clad switchgear in accordance with ANSI/NETA ATS, including performing:
1) Ground-resistance tests.
2) Insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.
3) An over-potential test on each bus section, each phase-to-ground.
4) Insulation-resistance tests on each breaker. Test each pole, phase-to-phase and phase-to-ground.
5) Minimum pickup voltage tests on trip and close coils.
6) Trip each circuit breaker by operating each protective device.
7) Vacuum bottle integrity test across each vacuum bottle with breaker in open position.
8) Contact-resistance test on each breaker.
9) Control and metering wiring performance test.
10) Pickup parameters and timing tests on protective relays.

B. Manufacturer's Services

1. Unloading and Installation: Manufacturer's factory-trained representative shall be present during unloading of the equipment and installation in equipment's final location. Representative shall train installing personnel in advance in proper handling and rigging of equipment. This shall be at least 2 eight-hour days.
2. Manufacturer's factory-trained representative shall test system as specified in Paragraph 3.3.A of this Section. Representative shall operate and test system in presence of ENGINEER and verify that equipment conforms to requirements. This shall be at least (--2--) eight-hour days.
3. Manufacturer's factory-trained representative shall adjust system to initial settings as specified in Article 3.4 of this Section.
4. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
5. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during correction period specified in the General Conditions and Supplementary Conditions.
6. Replacement parts or equipment installed during correction period shall be equal to or better than original.
7. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of materials and equipment. Training requirements, duration of instruction, and other qualifications shall be

in accordance with Section on Instruction of Operations and Maintenance Personnel.

8. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 ADJUSTING

Calibrate, set, and program protective devices. Coordinate protective devices furnished under this Section and include the proper settings of all devices in accordance with the findings of study specified under Section 26 05 73, Electrical Power Distribution System Studies.

END OF SECTION

SECTION 16361
LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of metal enclosed low voltage power switchgear, rated 600 volts. 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. Related Work Specified Elsewhere:

1. Section 16000, Electrical Power and Systems.
2. Section 16100, Basic Electrical Material and Methods.
3. Section 16175, Instrument Transformers, Meters, Switches and Accessories.
4. Section 16450, Grounding.

1.2 SUBMITTALS

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

A. Electrical Elementary Diagrams and Internal Connection Diagrams.

B. Manufacturer's data indicating interrupting, withstand and continuous current ratings of all equipment components.

C. Arrangement and layout drawings of the switchgear enclosures depicting equipment and bus bar arrangement, size and number of busbars per phase, neutral and ground nameplate legends and overall dimension including areas of permissible cable entries. A list of material and components shall accompany the layout drawings.

D. Results of factory tests and field breaker setting tests as specified in paragraph 16361-3. 2.

E. Time current curves on 14-inch log-log transparency paper for all protective devices.

F. Mimic bus layout.

G. Catalog data on all electrical devices and components mounted on or within the switches.

1.3 QUALITY ASSURANCE

Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ANSI, American National Standards Institute.

B. NEMA, National Electrical Manufacturers Association.

C. UL, Underwriters laboratories.

1.4 QUALITY STANDARDS

A. The switchgear covered by these specifications shall be designed, tested and assembled in accordance with the following standards.

1. ANSI C37.20, Switchgear assemblies including metal enclosed busbars.
2. ANSI C57.13, Requirements for Instrument Transformers.
3. NEMA SG-5, Metal Enclosed Switchgear Assembly.
4. UL 1558, Switchgear Design.

B. Manufacturers offering products that comply with these specifications include:

1. General Electric Company.
2. Westinghouse Electric Corporation.
3. Or equal.

1.5 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.6 DELIVERY, STORAGE AND HANDLING

A. Arrange shipping splits as required for installation. Individually wrap each section and mount on shipping skids.

B. Store in a clean and dry space. Maintain factory wrapping or provide an additional

heavy canvas or heavy plastic cover to protect equipment from dirt, water, construction debris and traffic.

C. Handle in accordance with NEMA PB-2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish switchgear rated 600 volt, 3 phase, 3-wire or 4-wire, 60 Hertz. Brace buses and bus structures for the rms symmetrical amperes, short circuit as indicated on the Drawings.

B. Coordinate all primary parts of the metal enclosed equipment, including circuit breakers, fuses, buses, connections and insulators to withstand mechanical and thermal stresses for use on the proposed system.

C. Furnish steel channel sills with suitable drilled holes for mounting, aligning and bolting swltchgear in place. Method of mounting as indicated. Provide size recommended by switchgear manufacturer and acceptable to Engineer. Paint completed sills with two coats of aluminum paint or other acceptable corrosion-resistant finish before setting in place.

D. If switchgear equipment pads are located on concrete floor slabs, furnish painted steel channel mounting sills and anchor bolts, including location instruction for setting in place during construction of the concrete equipment pads.

2.2 ENCLOSURE

A. Switchgear shall be factory assembled and metal enclosed. Each unit shall consist of a stationary structure assembly and one or more air circuit breaker units, disconnecting devices, and other specified equipment. switchgear shall be suitable for 600V, 3 phase maximum service. Each unit shall be provided with a breaker hoist for removing the breaker for maintenance.

B. Switchgear shall be completely self-supporting structure of required number of vertIcal sections bolted together to form one metal enclosed switchgear 90 inches (2300 mm) high. Sides, top and rear covers are code gauge steel, bolted to switchgear structure. Frame structure members die-formed 11 gauge steel bolted together and reinforced at external corners, with rugged gussets internal and external to structure members. Switchgear frame shall be suitable for use as floor sills in indoor installations. Switchgear assemblies shall conform to NEMA Standard SG-5. The switchgear shall be furnished with an indoor NEMA 1 enclosure or walk-in outdoor NEMA 3R enclosure as required.

C. Outdoor switchgear shall be fully weatherproof, housed in a factory assembled outdoor enclosure, have lifting plates at the base of the structure, hinged aisle doors with rubber gaskets and pad locking provisions, asphalt base undercoating on the exterior bottom, interior lights, space heater per vertical section, outlets and light switch and space heater switch. Enclosure shall include front aisle space running the full length of the equipment, sloping roof, rear bolted hinged doors, breaker lifting device, wire meshed louvers and rodent guards.

2.3 Switchgear Construction

A. Provide switchgear with incoming line main devices in individually mounted construction, and feeder devices in group mounted construction. Incoming line main devices side or rear accessible through bolted-on covers. Group mounted devices, front accessible per NEMA standards, furnished with wiring gutters on front of distribution vertIcal sections of switchgear. Provide gutters with code gauge steel formed covers bolted to structure frame. Cover unused device space with blank code gauge steel formed covers.

B. Construct metal-enclosed swltchgear structure from formed sections of specially smoothed and leveled steel, not less than 11 gage, welded together and reinforced, where necessary, with formed steel members. Resulting structure shall be totally enclosed, self supporting free-standing.

C. Make provision for conduit and cable entrance from top or bottom as indicated.

D. Enclose bus compartments and the instrument and control power transformer compartments completely with sheet steel and separate from each other by means of tightly fitted steel barriers.

E. Where space is indicated, provide compartment complete with buses, bus supports, insulators, primary and secondary disconnects, rails and other accessories to require only insertIon of breaker removable element. Provide insulating barriers in switchgear units to cover all live parts.

F. Each breaker compartment shall be equipped with primary and secondary contacts, rails, and stationary levering mechanism. A rear hinged cover shall be provided for each cable compartment, and a front hinged door shall be provided for each breaker and metering component.

G. Structures shall be provided with horizontal and vertical barriers to separate different voltage classes, buses and incomng cables.

2.4 BUS BARS

A. Main bus and riser bus shall be tin plated copper supported with high impact, non-tracking insulating material, and braced to withstand mechanical forces exerted

during short circuit conditions, to rating of protective devices as indicated.

B. Contact surfaces of main bus joints and all tap connections shall be silver plated.

C. Current density of bus not to exceed 750 amperes per square inch cross-section. If main circuit protective device is provided, continuous current rating of bus shall be equivalent to frame size rating of that device.

D. Furnish a ground bus and secure to each vertical section structure. Extend ground bus for entire length of switchgear. Ground bus shall have momentary rating equal to highest circuit breaker momentary rating in the assembly and provided with one clamp type terminal at each end for No. 4/0 bare copper ground. Ground bus shall be copper.

E. Furnish a neutral bus for three phase, 4-wire system. Neutral bus shall have the same ampacity as the main bus. Neutral bus shall be copper.

2.5 CIRCUIT BREAKERS

A. Breaker element shall consist of a three-pole manually operated electrically and mechanically trip-free power circuit breaker with solid state, overcurrent trip device, arc quenchers, manual stored energy closing mechanism, mechanical pushbutton trip and position indicator. Breaker element shall be suitable for mounting on the drawout mechanism in the circuit breaker compartment. Main and feeder circuit breakers shall have a minimum interrupting current of 65,000 and 42,000 amperes (symmetrical) respectively at 480 volt.

B. Disconnecting devices shall be the self-aligning type with the disconnecting fingers mounted on the breaker. The drawout mechanism shall, rigidly hold the circuit breaker in the fully connected, test, and fully disconnected positions. Interlocks shall be provided to prevent moving the circuit breaker from fully connected, test, or fully disconnected positions unless the breaker is open. Interlocks shall also prevent closing the breaks between any of these, positions.

The drawout mechanism shall be designed so that the breaker can be racked to any position without opening the door. A hasp on the breaker escutcheon shall be provided that can receive three padlocks when the breaker is in the open position.

C. Unless otherwise specified, breakers shall.be equipped with one normally open and one normal closed auxiliary switch. Switches shall be rated 10 amperes, 120 volts AC wired to terminal blocks.

D. Solid state tripping devices shall consist of current sensor logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame, and shall not require external relaying or power supplies. Tripping device for feeder breakers shall include current indicating

function for each phase, utilizing a digital, LCD display with a clear plastic cover.

Tripping device shall be provided with manually resettable fault indicators. As a minimum, fault indicators shall provide indication of tripping caused by overload, short circuit or ground fault.

Tripping functions shall be field adjustable and shall provide, as specified, the following tripping characteristics:

1. Overload Tripping:
   a. Adjustable ampere setting
   b. Adjustable long-time delay

2. Short Circuit Tripping:
   a. Adjustable short-time pick-up
   b. Adjustable short-time delay
   c. Adjustable instantaneous pick-up

3. Ground Fault Tripping
   a. Adjustable ground fault pick-up
   b. Adjustable ground fault delay.

4. Ground fault protection for main circuit breakers shall be accomplished by hard wired relay 51G, and shall not be included in the solid state tripping device.

E. Ground fault relays for double ended, multiple grounded configurations shall be fully responsive to ground fault currents returning to either source, and shall not respond to line to neutral currents.

F. Provide three 50/51 overcurrent relays and one 51G ground overcurrent relay for transformer secondary overcurrent protection.

2.6 WIRING

A. Switchgear shall be completely wired at factory. All secondary shall be made with standard switchgear wire and cable, single conductor 90^0 C copper wire UL listed for panel wiring, minimum size No. 14 AWG.

B. Provide acceptable terminal blocks with marking strips for all secondary circuits leaving metal enclosed structure and for interconnecting separate compartments.

C. Enclose all wiring between stationary units in metal raceway or compartments with removable covers.

D. Where wiring connections are made to equipment mounted on hinged doors, provide

terminal blocks or wire cleats for all secondary and control circuits leaving metal enclosed structure and for connecting separate compartments. Conductor markers shall be as specified in Section 16120.

2.7 CONTROL POWER TRANSFORMERS

Control power transformers shall be rated 480-120 volts, single-phase, 2-wire, 60 Hertz, with kva rating as required by switchgear, but not less than 1.0 kva. Mount current limiting primary fuses for control power transformer on disconnecting or drawout fuse mounts. Provide secondary fuses.

2.8 INSTRUMENTS, RELAYS AND CONTROL EQUIPMENT

A. All instruments and relays shall be provided with semiflush mounted cases and dusttight. All relays, instruments and meters shall be accurately calibrated for satisfactory operation after installation. instrument relays shall conform to NEMA Std. 11-2.

B. Protective devices shall be adjusted to the settings specified in Section 16100, prior to energizing switchgear.

C Fuse blocks and fuses shall be provided as required, for the protection of the instruments.

D. Suitable rated current and potential test blocks shall be furnished with matching plugs, for connecting external instruments installed as indicated. Test blocks shall be 6- or 8-point, suitably marked and connected for inserting both current and potential test leads.

E. Indicating instruments and control switches shall be in accordance with Section 16175, Instrument transformers, Meters, Switches and Accessories.

2.9 NAMEPLATES

Provide nameplates for switchgear main and feeder breakers engraved on laminated plastic with black lettering on white background. Name plates shall comply with Section 16100-2.9.

2.10 PAINTING

A. All steel surfaces of switchgear assembly shall be chemically cleaned and finished with ANSl No. 61 gray enamel over rust-resistant undercoat. Exterior of outdoor enclosures shall be finished per Section 09900, painting.

B. All meters, instruments and relays shall be provided with dull black finish.

2.11 SPARE PARTS

A. Provide spare parts as recommended by manufacturer.

B. Package spare equipment in suitable containers bearing labels clearly indicating contents and in what equipment used.

C. Deliver spare parts at same time as equipment. Properly store and safeguard such spare parts until completion of work, at which time deliver as directed by the Engineer.

2.12 MIMIC BUS

Provide a laminated, plastic mimic bus illustrating single line diagram identifying breaker numbers and load supplied by the breaker. Permanently mount the mimic bus with stainless steel screws.

2.13 FACTORY TESTS

A. After assembly, switch gear shall be tested for operation at the specified voltage and current ratings. The main circuits shall be given a dielectric test of 2200V for 1 minute between the live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500V for 1 minute between the live parts and ground.

B. Instrument transformers shall have ratio and phase angle tests made in conformance with ANSI C57.13.

C. Three copies of test results shall be submitted to the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Properly set and level channel sills.

B. Furnish complete, clear; and concise instructions for installation, operatIon, and maintenance of the equipment

3.2 FIELD TESTS

A. The protective devices shall be adjusted to the settings specified in the coordination study prior to energizing the switchgear.

B. Each switchgear breaker shall be tested in accordance with Section 16999.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of grounding system. All work 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 considered as being included in the price bid for the work shown and specified.

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
Test Reports: Submit directly to the Engineer two copies of the test reports certified by the testing technician.

1.3 QUALITY ASSURANCE

Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
A. NEC, Article 250.
B. IEEE 81-83.

1.4 DELIVERY, STORAGE AND HANDLING

Materials shall be delivered to the site and stored in the area assigned.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ground rods shall be ¾ inch diameter by 10 feet long, copper-clad steel, Josyln, or equal. Ground rods shall be sectional type with threaded type removable caps and coupler, where lengths greater than 10 feet are required.

B. Conductors shall be stranded copper, except that No. 6 A.W.G., when installed bare, shall be solid. When installed in raceways, conductors shall have specified 600 volt insulation, color coded green.

C. Exposed or accessible connections shall be made with copper or bronze grounding clamps, lugs, through-bolts, or other fittings specifically intended for such use such as grounding bushings, etc. Underground or other inaccessible connections shall be made by the exothermic welding process.

D. Aluminum grounding materials will not be accepted.

PART 3 - EXECUTION

3.1 APPLICATION

Items to be grounded shall include, but not necessarily be limited to, the following:

A. Steel building structures and all other above-ground metal structures.

B. Metallic raceways.

C. Electrical equipment enclosures.

D. Electrical system neutrals, only, at the point of supply.

E. Ground buses of switchboards, motor control centers, panelboards, etc.

F. Grounding pole of all receptacles.

G. Lighting fixture housings, outdoor metal light poles, etc.

H. Motors and other electrically operated equipment.

I. Outdoor metal fences.

J. Telephone service equipment (provide grounding leads only).

K. Lightning arresters (where required).

L. Medium and/or high voltage structures, housings, hardware, cable shields, static wires, etc., where applicable, other than items which are Utility Company owned.

M. Transformers.

N. Any equipment likely to become energized due to a malfunction

O. Ground grid systems with ground rod and water pipe connections.

3.2 INSTALLATION

The grounding installation shall conform with requirements indicated on the drawings and with the following:

A. Ground rods shall be driven vertically with top of rod 4" below grade, except that, where solid rock is encountered, rods may be tilted or, where necessary, may be placed horizontally.

B. Below grade grounding loops, mats and/or leads shall consist of 4/0 bare stranded copper cable not less than 2'-6" below the finished surface. Where indicated to be outside of building perimeter or other structure lines, foundation pads, etc., conductors shall be located not less than 3 feet, horizontally, outside of building foundations or from the edge of pads, etc.

C. Grounding risers shall be properly located so as not to comprise an obstruction or hazard to vehicle or pedestrian traffic. Risers for grounding steel columns shall rise within the concrete piers but shall clear column base-plates. Connections to exposed columns shall be "CADWELD" or "THERMO-WELD" type, located approximately 12 inches above the finished surface, and shall be made to the web of H shapes and to the inner surface of channels or angles. Connections to furred or otherwise inaccessible columns shall be made by brazing or welding. Risers to floor mounted equipment, such as switchboard, motor control centers, etc., shall be accessibly located under the equipment and be connected with bolted lugs. At permanent walls risers intended for extension within the building shall rise into an adequately sized junction box, surface or flush mounted to match other wiring within the area, approximately 1 foot above the floor, from which it shall be extended as insulated wire in conduit to the item or items to be grounded. Risers for extension or connection by others shall be left with approximately 4 feet of conductor coiled.

D. Grounding jumpers shall be provided between the building grounding system or the grounded building structure and every incoming metal underground cold water pipe, including all sprinkler risers where such exist.

E. Size of grounding conductors shall not be less than called for on the drawings, and otherwise shall not be less than the following:
   1. 4/0 A.W.G. for all buried or otherwise inaccessible conductors.
   2. For grounding A.C. system neutrals, as required by N.E.C. Table 250-94.
   3. For raceway and equipment grounding, as required by N.E.C. Table 250-95.
   4. No. 2 A.W.G. where installed exposed.
   5. For grounding low voltage ground buses, as required by NEC Table 250-94.

F. Grounding conductors, insulated and color coded green, shall be provided in all low voltage feeder and sub-feeder and branch circuit conduit runs, except low voltage service entrance conduit runs which contain a grounded neutral. These grounding conductors shall be connected to all metallic conduits by means of approved grounding bushings at all conduit terminations at the supply end of such circuits.

G. Outdoor metal fences provided under this Contract shall be bonded in not less than 3 places to an underground 4/0 grounding conductor extending not less than 25 feet on each side of the overhead line with not less than 3 ground rods bonded thereto, one in the center and one at each extremity. Fences around outdoor electrical substations shall be bonded to the substation grounding loop or grid at each corner post, at each gate post, and otherwise at points not greater than 25 feet apart, with flexible bonding jumpers provided for each gate.

H. Install sufficient ground rods in addition to code required grounding so that resistance to ground as tested by standard methods does not exceed 2 ohm unless otherwise accepted. Where more than one rod is required, install rods at least 10 feet apart.

I. Provide a bare conductor through each ductbank, connected to manhole/handhole ground rod. Connect to building ground grid or equipment frame as applicable.

J. Provide a logic ground for main computer and each PLC based local control panel separate from the power system ground. Route a 1/0 insulated copper conductor in a ¾-inch conduit to a ground cluster outside the building.

K. Were the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, the Contractor shall provide an additional isolated ground conductor from the equipment through the instrument power panel for connection to a ground cluster outside the building. The isolated ground conductor shall have green insulation with a

yellow stripe and shall be run in the same raceway as the power and neutral conductors.

3.3 GROUNDING CONNECTIONS

A. Unless shown otherwise, make connections of grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection point below finished grade. Provide ground well, as shown on the Drawings to allow for inspection.

B. Make connections of sections of outdoor ground mats (counterpoise) for substations or other equipment underground. Make connections of other grounding conductors generally accessible.

C. In handholes and manholes, install ground rods with ends 4 to 6 inches above the floor with connections of duct bank grounding conductors fully visible and accessible.

D. When making thermo welds, wire brush or file the point of contact to a bare metal surface. Use thermo welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly clean the joint. For compression connectors, use homogeneous copper, anticorrosion, surface treatment compound at connectors in accordance with connector manufacturer's recommendations. Use connectors of proper size for conductors and ground rods specified. Use connector manufacturer's compression tool. Notify Engineer prior to backfilling any ground connections.

E. Compression connectors shall be cast copper as manufactured by Thomas and Betts or equal.

3.4 EQUIPMENT GROUNDING

A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment with copper wire sized in accordance with NEC. Grounding conductors installed in conduit furnished with green, 600-volt insulation.

B. Connect transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, motor control centers and all outdoor substation equipment. Ensure that each connection for item of equipment is from different section of ground grid.

D. Install a separate grounding conductor from ground system to motors of 480 volts and higher, in addition to raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.

E. Connect lightning arrestors to ground system by suitable conductors.

F. Ground each street lighting standard by ground rod driven near base of standard, in accordance with requirements of NEC. Connect ground rods to grounding connector brought with street lighting feeder cable.

G. Where lightning arrestors are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arrestors with system ground.

H. Bond service entrance equipment ground bus in each building to the ground grid with a #4/0 bare copper conductor.

3.5 FIELD TESTS

A. Test in the Engineer's presence the ground resistance of the grounding system.

B. The Contractor shall test the resistance of the grounding electrode system by the fall of potential method. The Contractor shall supply a Biddle No. 6322 Earth Tester, or equal, and make the test in the presence of the Engineer with grounding conductors disconnected. If the grounding electrode test resistance exceeds 1 ohm, the Contractor shall add ground rods or other grounding electrodes to the grounding electrode system until the grounding electrode test resistance is 3 ohms or less. Methods which change soil resistivity are not acceptable as means of lowering the grounding electrode test resistance. This test shall not be made within 24 hours after rainfall.

C. Test all ground fault circuit interrupter (GFCI) receptacles and circuit breakers for proper connection and operation with methods and instruments prescribed by the manufacturer.

D. Provide copies of reports of all grounding system tests for inclusion in Operation and Maintenance Manuals and for review by the Engineer

END OF SECTION

SECTION 16451

DRY-TYPE LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install dry type low-voltage distribution transformers.

B. Related Sections:
1. Section 16000, Electrical Power and Systems.
2. Section 16450, Grounding.
3. Section 16195, Identification for Electrical Systems.

1.2 REFERENCES

Standards referenced in this Section are:

A. NEMA ST-20, Dry Type Transformers for General Applications.

B. NEMA TP-1, Guide for Determining Energy Efficiency for Distribution Transformers.

C. NEMA TP-2, Standard Test Method for Measuring the Energy Consumption for Distribution Transformers.

D. UL 1561, Dry Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

Regulatory Requirements:
NEC Article 450, Transformers and Transformer Vault (Including Secondary Ties).

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Schedule of transformers to be furnished with ratings and other required technical data.
b. Proposed location for each transformer, including pad layout, dimensions, and appurtenances.

2. Product Data:

Supplier's technical information for transformers proposed for use.

1.5 WARRANTY

Contractor shall warrantee the work in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Dry Type Two-Winding Transformer:
   1. Type: Dry type, air cooled, low temperature rise. Transformers 15 kVA and larger shall be energy efficient, complying with NEMA TP-1 Class 1 efficiency levels. Transformers less than 15 kVA shall be general purpose.
   2. Rating: KVA, primary voltage and connection, secondary voltage and connection, frequency and number of phases shall be as shown on the Drawings.
   3. Insulation: Insulation and average winding temperature rise (in a 40 degree C maximum ambient) for rated kVA per the following table. Energy efficient transformers shall be capable of 15 percent continuous overload at 150 degrees C temperature rise.

kVA Rating	Insulation Class (degrees C)	Temperature Rise (degrees C)
1 to 15 kVA	185	115
25 to 500 kVA	220	115

   4. Winding Taps, Transformers 15 kVA and Less: Two 5-percent below rated voltage, full capacity taps on primary winding.
   5. Winding Taps, Transformers 25 kVA and Larger: Two 2-1/2-percent above rated voltage and four 2-1/2+ percent below rated voltage, full capacity taps on primary.
   6. Basic impulse level shall be 10 kV.
   7. Sound Level: NEMA ST-20 standard.
   8. Enclosure: UL listed for the application.
   9. Identification: Identify transformers in accordance with Section 16195, Identification for Electrical Systems, with the transformer number and voltages, connection data, kVA ratings, impedance, and overload capacity.
   10. Transformers shall comply with NEMA ST-20, NEMA TP-1, NEMA TP-2, and UL 1561.
   11. Transformers shall bear the label of the Underwriters' Laboratories, Inc.

B. Manufacturers: Provide products of one of the following:
   1. Cutler-Hammer.
   2. General Electric Company.
   3. Square D Company.
   4. Siemens.

5. Or equal.

PART 3 - EXECUTION

3.1 INSPECTION

Examine the conditions under which the dry type transformers are to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on walls or floors at locations shown. Install floor mounted transformers on raised concrete bases. Provide sufficient access and working space for convenient and safe operation and maintenance.

B. Mount transformers so that vibrations are not transmitted to the building structural parts and other equipment. Make connections to transformers with flexible conduit.

C. Adjust tap settings to provide proper voltage at panelboards.

D. Install dry type transformers in conformance with governing codes and manufacturer's instructions and recommendations, and the Contract Documents.

E. Ground transformer in accordance to the National Electrical Code.

END OF SECTION

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SECTION 16481
LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of low voltage motor control centers. 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. Motor horsepower ratings and enclosures shown are what is expected. This information is for guidance only and does not limit the equipment size. When motors furnished differ from the expected ratings indicated, obtain the Engineer's review before proceeding.

D. Related Work Specified Elsewhere:

1. Section 16000, Electrical Power and Systems.
2. Section 16100, Basic Materials and Methods.
3. Section 16121, Instrumentation and Communications Cable.
4. Section 16450, Grounding.
5. Section 16999, Acceptance Testing and Calibration.

1.2 SUBMITTALS

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

A. Elementary diagrams. Provide a separate elementary diagram for each starter unit following the format shown on the Contract Drawings and showing numbered terminal points and interconnections of remote devices.

B. Reference Data. Submit one set of full size (11" x 14") time current curves on log-log transparency paper for all overcurrent protective devices. Exception: A tabulation of heater sizes or elements versus motor current rating may be submitted in lieu of time current curves for overload relays.

C. Operation and maintenance data including recommended maintenance procedures and intervals, spare parts listing, and instruction books for the equipment and components.

D. List of starters and feeder compartments indicating the size and type of current protection.

1.3 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. NEMA, National Electrical Manufacturers Association
2. UL, Underwriters laboratories.

B. Provide a UL label where applicable, on each unit and each vertical section. If a unit or section cannot be UL labeled so note on submittals along with reasons for same.

1.4 QUALITY STANDARDS

A. Provide Arc Shield or Arc Resistant Type motor control centers manufactured and tested in accordance with IEEE C37.20.7, NEMA ICS-18 and UL 845.

B. Manufacturers offering products that comply with these specifications include:

1. General Electric Evolution 9000 Line.
2. Cutler-Hammer F2100.
3. Allen Bradley Centerline 2100.
4. Square D Model 6.
5. Or equal.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Arrange shipping splits as required for installation. Individually wrap each section and mount on shipping skids.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.6 WARRANTY

Contractor shall warrantee the work in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 RATINGS

A. Service: 480 Volt, 3 Phase, 60 Hz.

B. Short Circuit: Unless otherwise indicated device interrupting rating and bus bracing is 65,000 amperes RMS symmetrical. Provide fully rated devices; series ratings are not acceptable.

C. Ampacity: 300 amps minimum for vertical bus, as indicated for horizontal bus. Rating to be in accordance with UL standards for temperature rise and a half size neutral bus where specified.

2.2 CONSTRUCTION

A. Equipment consists of the required number of vertical sections to accommodate all devices indicated and specified herein, each nominally 90 inches high and 20 inches deep. Sections are bolted together to form a rigid free standing, front accessible, dead front assembly. Only 72 inches must be used for mounting starters and breakers.

B. Provide each section with isolated horizontal wireways at the top and bottom and isolated vertical wireways with hinged door and cable tie supports. Unused spaces are to have bussing for future units and blank door covers.

C. Indoor enclosures shall be NEMA 1A gasketed painted in the manufacturer's standard grey over a rust inhibitor treatment. Outdoor enclosures shall be NEMA 3R, non-walk-in.

2.3 INCOMING MAINS

A. Provide incoming main circuit breaker. Main breaker shall be molded case type with thermal magnetic trips meeting UL 489 and NEMA AB-1.

B. Arrange main breaker for cable entry without requiring 90 degree bends in the incoming conductors.

C. Where motor control centers serve as service entrance equipment, provide a UL service entrance label on the incoming section.

2.4 STARTER UNITS

A. Starters: Circuit breaker combination type with contactor rated in accordance with NEMA size designations. Fractional sizes and ratings per IEC recommendations are not acceptable. Minimum size shall be 1.

B. Breakers: Adjustable magnetic trip only equipped with current limiters as required for the interrupting rating noted.

C. Contactors: NEMA 165-2; NEMA Size 1 minimum; magnetically held; field replaceable coil and contacts; auxiliary contacts field installable and removable. Terminal temperature rise is not to exceed 50^0 C per NEMA standards. Provide two normally open and two normally closed auxiliary contacts, rated 10 amperes at 120 volts AC, wired out to terminal blocks, unless otherwise shown on the Drawings.

D. Overload Relays: Overload relay shall be provided with three heater elements; ambient compensated; adjustment from 90 to 110 percent of normal heater ratings; bimetal type; normally closed, isolated auxiliary contact; manually reset by means of an external reset button; and capable of handling the horsepower range of the starter by changing the thermal elements only. Provide one (1) three phase sets of N.O. or N.C. contact of the overload as shown on the drawings for each starter.

E. Units: Constructed to fully compartmentalize the starter and arranged to permit access to starter, control power transformer, fuses, and other components without requiring disassembly. NEMA size 1 thru 4 are plug in, size 5 and larger are bolt on. Equip unit door with a defeatable interlock to prevent opening unless the disconnect is open. Equip disconnect operator to accommodate three padlocks in the "OPEN" position.

F. Terminal Blocks: Pull apart type for power and control to allow unit withdrawal without disconnecting wiring. Use screw type terminals suitable for ring and tongue lugs for control wiring and box lug type for power wiring.

G. Provide an encapsulated surge suppressor for each starter unit, for direct mounting to the starter coil. Suppressor shall be rated 120VAC, with no additional panel space required.

H. Motor control centers shall be provided with NEMA Class I, Type "B" wiring. Provide terminal blocks for control wiring as shown on the Drawings. terminal blocks shall be provided for power wiring for starter size 2 and smaller. Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2.5 FEEDER UNITS

A. Breakers: Molded case type, thermal-magnetic trips meeting UL 489 and NEMA AB-1. Ampere rating and interrupting ratings as noted.

B. Units: Individually compartmentalized with not more than one breaker per unit unless otherwise indicated. Use red color to indicate on position as described above for starter units.

C. Breaker shall be equipped with toggle type handle, quick-make, quick-break mechanism, ON-OFF position clearly indicated. Minimum short circuit capacity 25,000 amps.

2.6 BUS

A. Material: Copper, tin plated at all joints.

B. Isolation: Locate main bus at the top or center, completely compartmentalized with sliding or removable barriers for access to joints. Provide phase isolation for vertical bus by polyester barriers enclosing each phase bar or providing adequate creepage to restrict fault propagation. Plug all holes not used to stab in units.

C. Provide ground bus rated 300 amps minimum extending the full length of the lineup. Where three phase, four wire control centers are indicated provide full length neutral bus rated a minimum of 50 percent of the main bus. Where three phase three wire control centers are used as service entrance equipment provide neutral bus in the incoming main section only.

2.7 METERING RELAYING AND CONTROL DEVICES

A. Instrument transformers and metering devices shall meet the requirements of Section 16175.

B. Elapsed time indicator: Six digit, non-reset, 3-½-inch square case; equal to GE type 236.

C. Indicating lights, pushbuttons and selectors: Heavy duty, oiltight, industrial grade with octagonal ring. Pilot lights are transformer type. Equal to Allen Bradley Bulletin 800T.

D. Control Relays: Heavy duty, 600 volt, industrial grade, 10 amp contact rating. Equal to Allen Bradley bulletin 700 type P.

E. Supply individual control power transformers where indicated. The transformers shall have sufficient capacity to serve the connected load plus 100 VA and limit voltage regulation to 15 percent during contactor pickup. Fuse one side of the secondary winding and ground the other side. Provide two primary, current limiting fuses. Provide each starter unit with blown fuse indicators.

F. Each starter unit shall be provided with a motor control circuit disconnecting device that meets the requirements of NEC 430-74(a).

2.8 SPARE PARTS

A. Starter Contacts: One (1) set for each NEMA size furnished.

B. Starter Coils: One (1) for each NEMA size furnished.

C. Control Circuit Fuses: Three (3) for each rating furnished. Provide one (1) fuse puller.

D. Pilot Light Lamps: Standard lot cartons equal to ten (10) percent of the number of lights furnished, one carton minimum.

E. Touch-Up Paint: One (1) can.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with the manufacturer's instructions.

B. Settings: Install the adjustment stop pin on magnetic only breakers so that the adjustment cannot exceed 13 times the full load amps. When the line voltage is at or above its normal value, adjust each magnetic only breaker to the lowest value that will allow reliable starting. Install the correct thermal overload relay element in each motor starter. The sizing of the overload element shall be based on motor nameplate amps, motor service factor, expected difference between motor and starter ambient temperature, any other factors the starter manufacturer requires. Prepare a table of motor name,motor horsepower,nameplate full load current, heater catalog number, heater current range, protective device trip setting, and include a copy in the Operations and Maintenance Manual.

C. Install control centers on 4-inch concrete pads and secure to sills imbedded in the concrete with ½-inch threaded bolts and nuts.

D. Touch up paint scratches and vacuum to remove construction debris and dirt. Install all doors, wireway covers etc., and plug any unused device holes.

3.2 TESTS

A. Install overload relay thermal elements based on motor nameplate rating. If capacitors are installed between the relay and motor, select thermal elements based on the measured motor current. Adjust other overcurrent protective devices to settings per the coordination study.

B. Megger each bus, phase-to-phase and phase-to-ground.

C. Motor control centers shall be tested in accordance with Section 16999, Acceptance Testing and Calibration

END OF SECTION

SECTION 16485
CONTACTORS

PART 1 - GENERAL

1.1 SCOPE

A. Lighting contactors.
B. Enclosures.

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
Product data. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.

1.3 WARRANTY

Contractor shall warrantee the work in accordance with the General Conditions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. General Electric.
B. Square D.
C. Westinghouse.
D. Or equal.

2.2 LIGHTING CONTACTORS

A. Contactors: NEMA ICS-2; magnetically held, 2 wire control.
B. Coil Operating Voltage: 120 volts, 60 Hertz.
C. Contacts: as indicated.
D. Enclosure: NEMA ICS-6; Type 1.
E. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.1 INSTALLATION

Install in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 16510

INTERIOR LUMINAIRES

PART 1 - GENERAL

1.1 SCOPE

This Section includes interior lighting Luminaire lamps, drivers and accessories. Luminaire include lamps and parts required to distribute the light, position and protect lamps and connect lamps to the power supply. Interior luminaires specified to be installed under this section should be erected, and placed in proper operating condition in full conformity with electrical drawings unless electrical engineer notes exceptions.

1.2 SECTION INCLUDES

A. Interior L.E.D. luminaires.

B. L.E.D. Drivers.

C. L.E.D. Lamps.

D. Luminaire accessories.

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaires that is not a standard product of the manufacturer.

B. Product Data: Provide dimensions, ratings, and performance data.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Operation and Maintenance Data: Instructions for each product.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70 and NFPA 101.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

D. Listing and Labeling: Provide Luminaire and emergency lighting units that are listed and labeled for their indicated use on the Project.
   1. Special Listing and Labeling: Provide Luminaire for use in damp or wet locations, specifically listed and labeled for such use.
   2. The terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
   3. Listing and Labeling Agency Qualification: A "Nationally Recognized Testing Laboratory" *NRTL) as defined in OSHA Regulation 1910.7.

E. Manufacturer Qualifications. Firms experienced in manufacturing Luminaire that are similar to those indicated for this Project and that have a record of successful in-service performance.

1.5 RELATED SECTIONS

A. Section 16100 – Basic Materials and Methods

B. Section 16123 – Building Wire and Cable

C. Section 16140 – Wiring Devices

1.6 REFERENCES

A. NECA/IESNA 500 - Recommended Practice for Installing Indoors Commercial Lighting Systems; National Electrical Contractors Association; 2006.

B. NECA/IESNA 502 - Recommended Practice for Installing Industrial Lighting Systems; National Electrical Contractors Association; 1999.

C. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association; 2002.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

E. NFPA 101 - Code for Safety to Life from Fire in Buildings and Structures; National Fire Protection Association; 2006.

1.7 WARRANTY

Submit a warranty, mutually executed by manufacturer and the Installer, agreeing to replace rechargeable system batteries that fail in materials or workmanship within the warranty period specified below. This warranty is in addition to, and not a limitation of, other rights and remedies the Owner may have under the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Eaton.

B. Cooper.

C. Crouse-Hinds.

D. Engineer Approved Equal

2.2 L.E.D. LUMINAIRES

A. Furnish products as indicated in Schedule on drawings.

B. Light source: Light emitting diodes (LEDs).

C. Construction: suitable for area classification indicated on Drawings.

D. Finish: Corrosion resistant NEMA-4X suitable for area classification indicated on Drawings..

E. Accessories: Provide luminaires complete with all installation accessories.

2.3 L.E.D. DRIVERS

A. Luminaires shall be equipped with an L.E.D. driver(s) that accepts the voltage as indicated on the "Luminaire (Lighting Fixture) Schedule". Individual driver(s) shall be replaceable.

B. Driver(s) shall be UL8750 class 2 compliant for their intended Purpose.

C. Total harmonic distortion (THD) for current: ≤ 20%

D. Driver(s) shall be rated to operate between -30ºC to 50ºC minimum.

E. Driver(s) shall be equipped with surge protection (6kV minimum) in accordance with IEEE/ANSI C62.4.1. Driver shall be protected against damage due to either an open circuit or short circuit fault condition on the driver output.

F. Driver(s) shall have a minimum efficiency of 85%.

2.4 L.E.D. LAMPS

A. L.E.D. lamps shall be high-efficiency long-lifetime type.

B. L.E.D. lamps shall have a minimum lifetime of 50,000+ hours at 40º C and shall have a minimum efficiency of 80 lumens per watt.

C. L.E.D. lamps shall be tested in accordance with I.E.S.N.A. LM-80-08 standards.

D. Thermal management shall be passive by design and shall consist of heat sinks with no fans, pumps, or liquids.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install Luminaire securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting).

B. Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaires at indicated height.

C. Install accessories furnished with each luminaire.

D. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaires.

E. Bond products and metal accessories to branch circuit equipment grounding conductor.

3.2 FIELD QUALITY CONTROL

A. Perform field inspection in accordance with Section.

B. Operate each luminaire after installation and connection. Inspect for proper connection and operation.

3.3 ADJUSTING

A. Aim and adjust luminaire as indicated.

B. Position exit sign directional arrows as indicated.

3.4 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

3.5 TESTING, DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate luminaires operation for minimum of two hours.

B. All testing shall be performed in accordance with the requirements of the General conditions and Division 1. The following Tests are required:
   1. Witnessed Shop tests
      None Required
   2. Certified Shop Tests
      The lighting Luminaire shall be given routine factory tests in accordance with the requirements of ANSI, NEMA and Underwriter Laboratories standards.

3.6 PROTECTION

Relamp luminaires that have failed lamps at Substantial Completion.

END OF SECTION

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SECTION 16515

ADJUSTABLE FREQUENCY, CONTROLLED SPEED, DRIVE SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of the adjustable frequency speed control systems complete. 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. Provide drive systems each consisting of the adjustable frequency controller, drive motor, certain auxiliary items, and other components necessary to provide a complete, compatible operating system.

B. The terms AFD (adjustable frequency drive), ASD (adjustable speed drive), VFD (variable frequency drive), and VSD (variable speed drive) are interchangeable for the purposes of this specification.

C. Output speed control of motor shall be continuous throughout speed range of two to 60 Hertz under variable torque load or constant torque as specified for the driven equipment.

D. Provide adjustable speed drives suitable for top and bottom conduit or cable entry.

E. Provide adjustable speed drives of the pulse width modulated type with provisions for operating without a motor for test and adjustment purposes.

F. This section specifies 480 VAC rated adjustable frequency drive motor controller systems with a rating of less than 200 HP using insulated gate bipolar transistors (IGBT) for pulse width modulation technology (PWM).

G. The AFDs specified in this section shall be the product of a single vendor and mounted in the specified cabinet enclosure.

H. 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.

I. The adjustable frequency, controlled speed, drive systems will be used to operate the equipment indicated in the Detailed Process Equipment Specification(s).

J. The manufacturer shall review the mechanical layout drawings to familiarize themselves with the location and set-up of the equipment specified and shall assure themselves that the equipment specified is appropriate for and coordinated with what is shown on the contract drawings.

K. The manufacturer shall also review the relevant electrical plan and one-line diagram and the relevant process and instrumentation diagram drawings to ensure that the contract drawings are appropriate and coordinated with the equipment controls specified and the monitoring and protection devices shown on the P&ID. The VFD manufacturer shall obtain the pump and equipment curves for which the VFD is being provided to ensure that the VFD covers the entire operating range of the equipment or the pump.

L. Related Work Specified Elsewhere:
1. Section 09900, Painting.
2. Section 16150, Electric Motors.
3. Section 16450 Grounding
4. Section 16000, Electrical Power and Systems.
5. Section 16999, Acceptance testing and calibration

1.2 DEFINITIONS:

A. Rated Load: The load specified for the equipment detailed in the items listed under RELATED WORK SPECIFIED UNDER OTHER SECTIONS.

B. Rated Speed: The nominal rated (100 percent) speed specified for the equipment detailed under RELATED WORK SPECIFIED UNDER OTHER SECTIONS.

1.3 SUBMITTALS

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

A. Overall system, power supply, and motor data, including efficiencies, input currents, and power factors, at driven equipment actual load and rated system input voltage, at 0, 40, 60, 80, and 100 percent of rated speed.

B. Complete system rating including all nameplate data, continuous operation load capability throughout speed range of 0 to 100 percent of rated speed.

C. Complete adjustable frequency controller rating; list any controller special features being supplied.

D. Motor, controller, and isolating transformer (if specified or required) dimensional drawings; information on size and location of space for incoming and outgoing conduit.

E. Layout of controller face showing all pushbuttons, switches, instruments, indicating lights, etc.

F. Complete system operating description.

G. Complete system schematic (elementary) wiring diagrams.

H. Complete system interconnection diagrams between controller, drive motor, and all related components or controls external to the system, including wire numbers and terminal board point identification.

I. Descriptive literature for all control devices such as relays, timers, etc.

J. Proposed factory and field test descriptions in sufficient detail to fully describe the specific tests to be conducted and quantities to be measured to demonstrate full conformance with these Specifications.

K. Spare parts being provided.

L. Component fabrication drawings consisting of detailed circuit schematics, printed circuit board drawings and chassis layouts for all electrical and electronic components.

M. Manufacturer's certification that controller can withstand fault conditions specified in paragraph 16515-2.2.

N. Manufacturer's certification that AFD can withstand environmental conditions specified in paragraph 16515-2.2.

O. Operation and Maintenance manuals.

P. Harmonic calculations.

Q. For each VFD, submit the get pump and equipment operating and power curves along with the VFD size being provided to demonstrate that the VFD being proposed covers the entire equipment operating range.

1.4 SYSTEM REQUIREMENTS

A. The AFD system shall convert 460 volt, 60-Hertz nominal input to a suitable voltage and frequency to cause a premium efficient, inverter duty motor to run at a speed proportional to an external input analog 4 to 20 ma dc or digital input command as specified for the required AFD speed range.

B. The AFD system shall include rectifier units, inverter units, control circuitry, protective equipment, input line reactors and output load reactors and other filters and accessories as necessary to provide the specified functions to meet voltage and current harmonics at the specified point of common connection and to mitigate the motor reflected voltage wave. Unless otherwise specified, the point of common connection for AFDs shall be the 480 distribution bus (motor control center, distribution panel, etc.) immediately upstream of the AFD.

C. The AFD system torque requirement shall match the pump torque requirement. Verify the pump type and select variable torque (VT) or constant torque (CT) as specified in the AFD Schedule.

1.5 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. IEEE 519-81, Guide for Harmonic Control and Reactive Compensation of Static Power Converters.
   2. NEMA 250-85, Enclosures for Electrical Equipment (100 Volts Maximum).
   3. NEMA ICS 2-88, Industrial Control Devices, Controllers and Assemblies.
   4. NEMA, ICS 3-88, Industrial Systems.
   5. NPFA 70-90, National Electrical Code, NEC.

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

C. Industry Standards: The AFD shall be UL 508 listed and shall conform to the requirements specified in NEMA ICS 2, 6, 7 and 7.1.

D. Should the adjustable frequency, controlled speed drive systems not perform as required, the Contractor shall repair or replace any units as

necessary to meet the Specifications. Costs for unit repair and retesting shall be the Contractor's responsibility.

1.6 QUALITY STANDARDS

A. The adjustable frequency speed control system shall be furnished by a single manufacturer who shall assume full 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. The Contractor shall assign unit responsibility for the variable frequency drives to the pump manufacturers. The Contractor shall submit letters of certification with the shop drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required for the actual motor sizes required regardless of deviations from the "nominal horsepower."

C. Manufacturer's offering products that comply with these Specifications include:
1. Eaton
2. Square D
3. Allen-Bradley
4. Or Equal.

1.7 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.8 EQUIPMENT NUMBERS

As shown on the drawings.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide adjustable frequency, controlled speed, pulse width modulated drive systems capable of converting 460 volt, 3 phase, 60-Hz, input power into variable voltage, adjustable frequency, 3 phase output of suitable capacity and waveform to serve as input power to the drive system motors. Provide an adjustable frequency controller for each motor indicated.

B. The driven load shall not exceed 87 percent of the rated capacity of the complete drive system and any of its components at any point on the pump curves.

C. The controller manufacturer shall provide line reactors, harmonic filters, or other devices necessary for proper system operation when supplied from the specified source. If more than one adjustable frequency drive is supplied from the same supply, provide necessary devices and circuits to prevent the operation of one drive from adversely affecting the operation of the other drives.

D. If rectification stage is controlled, it shall be a three-phase, full-wave bridge with silicone-controlled diodes in all six legs. Silicone controlled rectifiers (SCR) shall not be used.

E. AFD units shall be shipped in air-cushion vans to ensure against shipping damage and packed in suitable protective containers. The units shall be inspected upon receipt for damage.

2.2 ADJUSTABLE FREQUENCY POWER SUPPLY AND CONTROL PANEL

A. Provide a controller rated for 460 volt, 3 phase, 60 Hz input, suitable for operating the motor specified herein and driving the specified equipment.

B. Provide equipment suitable for the following service conditions:

Component	**Service Condition**
Input Voltage	+ 5% to -10% of rated
Input Frequency	± 5% of rated
Ambient Temperature	-10 to 40 degrees C
Altitude	Sea level to 3,300 feet
Humidity	0 to 95%

C. Provide equipment meeting the following requirements:

Component	Service Condition
In-service Deviation From Set Point Speed (due to variables other than load)	1 percent of full speed.
Efficiency	95 percent minimum at 100 percent speed.
Capacity	Suitable for operation continuously at its rated load.
Inrush Current Limitation	Adjustable, 50 to 100 percent, minimum, of rated current.
Equipment Short Circuit Rating	Suitable for connection to system with a maximum normal source short circuit available of approximately 30,000 rms symmetrical at 480 volts.
Harmonic Content Reflected into Supply System Voltage Waveform	Distortion factor as defined by IEEE Standard 519 of not more than 3 percent in the normal source; use a normal source impedance in the harmonic analysis based on a minimum 3-phase, bolted fault, short circuit of rms symmetrical at 480 volts 30,000 A.

D. Provide equipment with the following features:

1. Stranded copper wiring neatly bundled with nylon tie wraps or with continuous plastic spiral binding; each terminal labeled for permanent identification of all leads; each wire identified at each end with imprinted mylar adhesive back, or as approved, wire markers; wire and terminal numbers shown incorporated in as installed wiring diagrams; wiring across door hinges 19 strand, NEMA Class C stranding, or as approved, looped for proper twist rather than bending at hinge; wire connections internal to panels by crimp on, or as approved, terminal types; for multiple enclosure systems, complete interconnection wiring; multipoint plug receptacles for any control wiring crossing equipment shipping splits.
2. Selector switches, indicating lights, potentiometers, instruments, protective devices, major system components, etc., identified by means of mechanically attached, engraved, laminated name plates.
3. Line circuit breaker, mechanically interlocked with the enclosure door, and current limiting line fuses.

4. Control circuit disconnect to de energize all circuits in the unit which are not de energized by the main power disconnect device.
5. 115 volts, single phase, 60 Hz circuits for control power and operator controls.
6. Component and circuit arrangement such that failure of any single component cannot cause cascading failure(s) of any other component(s).
7. Solid state logic for inverter circuitry; necessary logic for inverter operation on plug in printed circuit boards.
8. For multiple unit systems, components necessary to prevent any unit in each drive system from interfering with the operation of any other unit in that system.
9. Linear timed acceleration and deceleration, adjustable up to at least 10 seconds.
10. Provision for adjustment of minimum and maximum pump speed.
11. Indicating light test pushbutton arranged so that all indicating lights can be simultaneously tested.
12. Nonresettable running time indicator with six digit display, the smallest digit representing 0.1 hour.
13. Motor speed indicator calibrated in percent of motor rated rpm.
14. Independent dry contact rated 10 amps, 120 volts, closing on motor operation for remote indication.
15. Independent dry contact rated 10 amps, 120 volts, closing when motor is not energized to control motor space heaters.
16. Independent dry contact rated 5 amps, 120 volts, minimum, closing when motor is not energized, for remote indication.
17. Following loss of power, orderly shutdown of system; following power restoration, restart drive automatically in normal sequence.
18. HAND-OFF-AUTOMATIC selector switch. When the selector switch is in the HAND position, the motor shall run in response to local (on the drive door) speed control. When the selector is in AUTO position, the motor shall start and stop in response to an external, RUN discrete signal; and the pump speed shall be controlled by an external 4 to 20 mA signal. When the HAND-OFF-AUTOMATIC selector is in the OFF position, the motor shall not operate.
19. In any mode, the motor shall stop until manually RESET when either of two remote contacts opens. This condition shall constitute a FAIL condition.
20. Provide isolated 4-20 ma output for remote speed indication.
21. VFD shall be provided with additional terminal blocks for termination of field equipment as shown on Drawings.
22. The VFD shall interface to motor winding temperature devices and shall shut down if the motor becomes overheated.
23. A thermal overload relay with element in all three phases shall provide overload protection.

E. Provide the following operator's control devices mounted on the face of the controller:
   1. Power ON indicating light, white lens.
   2. Motor ON indicating light, red lens.
   3. Motor OFF indicating light, green lens.
   4. System FAIL indicating light, amber lens, indicating any speed control system malfunction.
   5. Potentiometer for manual speed adjustment.
   6. Motor speed indicator.
   7. Running time indicator.
   8. RESET pushbutton.
   9. Lamp TEST pushbutton.
   10. Motor high temperature light.
   11. Ammeter.

F. Furnish Form C contacts for each of the following conditions:
   1. Motor is ON--wire to normally open contact.
   2. Drive is in AUTO mode--wire to normally open contact.
   3. Motor is ON for seal water solenoid valve--providing 120 volts ac through the normally closed contact to energize and close the seal water solenoid valve when the motor is OFF (de-energize and open the valve when the motor is ON).
   4. Drive failure.

G. The following functions shall latch until manually RESET:
   1. FAIL light.
   2. FAIL contact.
   3. Shutdown upon FAIL.

2.3 ENCLOSURES

A. General:
   1. Provide enclosures with AFDs and custom control as required for the project and as indicated on the drawings. Each drive shall be designed for stand-alone operation and multiple drives shall not utilize shared components. Review the project site location, elevation, temperature, humidity, plant atmosphere, and load current-torque requirements to size the AFD and its associated enclosure with requirements specified herein and the control and monitoring devices and interlocks as indicated.
   2. Enclosures shall be designed for indoor service. Each AFD system shall be mounted in a NEMA 250 internally force ventilated enclosure with UL approved Class 1 filters on ventilation openings. Enclosures shall be fabricated from 12-gage minimum thickness sheet steel with an interior frame or formed to provide a rigid structure.

3. Provide enclosure size to allow entry of power source and motor load cables as indicated on the drawings. Submit drawing of the source and load power cable location within the enclosure and indicated barriers from control and instrument wiring.
4. Door width shall not exceed 30 inches and shall be hung on removable-pin hinges, with three-point latch hardware, and handle latch for 3/8-inch-shackle padlock.

B. Finish and Coatings: AFD systems enclosures shall be finished with corrosion protection coatings inside and outside for hydrogen sulfide atmospheres. The electrical and electronic assemblies shall have conformal coatings.

2.4 EQUIPMENT GROUNDING

Provide means in all equipment for attaching grounding conductors. Ground equipment in accordance with Section 16450, GROUNDING.

2.5 SPARE PARTS

A. Provide a list of recommended spare parts for each system with unit prices. Include in the list items which would normally be expected to fail in the first 5 years of operating life.

B. Provide with the equipment a complete set of spare parts for each system to include components likely to fail in normal service. Parts provided shall include such items as plug in subassemblies and printed circuit boards, potentiometers, integrated circuits, and other discrete devices which would normally be field replaceable.

C. For each drive system, provide one complete spare printed circuit card for each modular, plug in type card in the controller.

D. For each type or frame size AFD, provide three sets of all replaceable fuses.

2.6 FACTORY TESTS

Factory test the drive system functional performance, proper operation, and proper wiring. Tests may be performed without the drive motor specified herein. Verify proper operation of all controls, instrumentation, and protective functions. Operate the controller with a motor throughout its specified speed range, and at rated power supply load for at least 1 hour.

2.7 PRODUCT DATA

The following information shall be provided in accordance with the General Conditions:

A. Operation and maintenance information as specified in Section 01800, including:
    1. Final reviewed submittal.
    2. As-built drive configuration settings.

B. Installation certification Form as specified in paragraph 16515 3.2.D.

C. Training certification Form as specified in paragraph 16515-3.3.C.

PART 3 - EXECUTION

3.1 GENERAL

Install all components in strict accordance with manufacturer's recommendations. Install all conduit, wiring, etc., in accordance with Division 16, ELECTRICAL.

3.2 FIELD INSTALLATION

A. Each adjustable speed controller shall be installed and tested by the Contractor with the assistance of factory-trained pump manufacturer engineer/technician and AFD engineer/technician in accordance with the manufacturer's specifications and Section 16515, and witnessed by the Engineer.

B. B. Manufacturers' factory representatives shall provide field testing for devices including the setup of the Operator Interface Unit and the setup of the data communication devices, where used. Upon satisfactory completion of the testing, the Contractor shall submit two certified copies of the test report to the Engineer.

C. Component failure during testing will require repeating any test associated with the failure or modified components to demonstrate proper operation.

D. The installation shall be certified on the appropriate Form as specified in Section 01600.
    1. Adjust drive and perform "start-up" tests as recommended by manufacturer. Set parameters and carrier frequency for existing motors to avoid insulation damage.
    2. Establish proper direction of rotation for the motor controlled by the drive. Verify that the AFD is precluded from operating in a direction that can damage the driven equipment. Change motor or AFD power lead connection and not the AFD direction, where rotation is incorrect.
    3. Verify that the drive will operate properly both in the "manual speed control mode" and in the "remote or automatic mode" from a remote speed signal input.

4. Set the maximum “locked rotor” current drawn during start-up recommended by the manufacturer and approved by the Engineer.
5. Set the minimum and maximum speeds and the acceleration and deceleration “ramps” recommended by the driven equipment manufacturer.
6. Verify the motor high temperature switch contacts are wired into the AFD 120 VAC control circuit and will trip on high winding temperature. Test or simulated the alarm and trip feature at the motor for high temperature and for high vibration, where used.
7. Operate the drive at 100 percent speed for one hour and monitor output current. The output current shall remain below the full load current listed on the motor nameplate.
8. Check for excessive heating of the drive and motor. Report any discrepancies to the Engineer.

3.3 TRAINING

A. Eight hours of onsite AFD operation and maintenance training shall be provided for the Owner’s Operation and Maintenance Staff.

B. Manufacturers’ factory representative shall conduct the training, upon acceptance of a resume submitted by the trainer.

C. Training shall be certified on the appropriate Form as specified in Section 01600.

3.4 FIELD TESTS

A. Functional Test: Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a functional test. Submit test procedure for review and acceptance by Engineer.

B. Vibration Test: The complete assembly, consisting of the motor, load, and flexible shafting, connected and in normal operation, shall not develop amplitudes of vibration exceeding limits recommended by the current edition of Hydraulic Institute Standards. Where loads and drivers are separated by intermediate flexible shafting, vibration shall be measured both at the top motor bearing and at two points on the top pump bearing, 90 degrees apart.

C. Performance Testing:
Demonstrate system performance by operating the system for an 8 hour continuous period while varying the application load, as the input conditions allow, to verify system performance. Record all data necessary to document the successful performance of the system. Provide all instruments, equipment, and labor required to accomplish this test. If a unit fails the performance test, the supplier will be allowed to readjust and

retest the system. If the unit fails the second test, the unit will be rejected and the Contractor shall furnish a unit that will perform as specified.

3.5 MANUFACTURER'S SERVICES

A. Manufacturer's services shall be provided in accordance with the requirements of Section 11000, General Material and Equipment Requirements.

B. A technically qualified manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum person-days listed for the services herein under, travel time excluded:
   1. 2 man-days (minimum) for installation assistance, inspection, performance testing and certification of the installation.
   2. 2 man-days minimum for functional testing.
   3. 2 man-day minimum for operator training.

END OF SECTION

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SECTION 16520

EXTERIOR LUMINAIRES

PART 1 GENERAL

1.1 SCOPE

This Section includes exterior lighting fixtures lamps, ballasts and accessories. Fixtures include lamps and parts required to distribute the light, position and protect lamps and connect lamps to the power supply. Exterior luminaires specified to be installed under this section should be erected, and placed in proper operating condition in full conformity with electrical drawings unless electrical engineer notes exceptions. Illumination levels: Per Illumination Engineering Society of North America Handbook recommendations.

1.2 SECTION INCLUDES

Luminaires, poles and accessories

1.3 SUBMITTALS

A. Shop Drawings: Indicate dimensions and components for each luminaire not standard Product of manufacturer.

B. Product Data: Submit dimensions, ratings, and performance data.

1.4 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.5 RELATED SECTIONS

A. Section 16100 – Basic Materials and Methods

B. Section 16123 – Building Wire and Cable

C. Section 16140 – Wiring Devices

D. Section 16450 – Grounding

1.6 DELIVERY, STORAGE, AND HANDLING

Store and handle metallic poles in accordance with industry guidelines and manufacturer recommendations.

1.7 COORDINATION

Furnish bolt templates and pole mounting accessories to installer of pole foundations.

1.8 MAINTENANCE MATERIALS

A. Furnish two of each lamp installed.

B. Furnish two gallons of touch-up paint for each different painted finish and color.

C. Furnish two ballasts of each lamp type installed.

1.9 REFERENCES

A. American National Standards Institute:
   1. ANSI C82.1 - American National Standard for Lamp Ballast-Line Frequency Fluorescent Lamp Ballast.
   2. ANSI C82.4 - American National Standard for Ballasts-for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type).
   3. ANSI O5.1 - Wood Poles, Specifications and Dimensions.

B. National Fire Protection Association: NFPA 70 - National Electrical Code.

C. Illumination Engineering Society of North America: Handbook.

1.10 WARRANTY

Contractor shall warrantee the work in accordance with the General Conditions.

PART 2 PRODUCTS

2.1 LUMINAIRES

Product Description: Complete exterior luminaire assemblies, with features, options, and accessories as scheduled.

2.2 FLUORESCENT BALLASTS

A. Manufacturers:
   1. Cooper Industries Inc.
   2. Duro-Test Corp.
   3. General Electric Co.
   4. Hubbell Lighting
   5. Magnetek Inc.
   6. Pass & Seymour.
   7. Philips Electronic North America

8. Thomas Industries, Inc.

B. Product Description: High-power-factor type electromagnetic ballast certified by Certified Ballast Manufacturers, Inc. to comply with ANSI C82.1, suitable for lamps and environmental conditions specified, with voltage to match luminaire voltage.

2.3 HIGH INTENSITY DISCHARGE (HID) BALLASTS

A. Manufacturers:
1. Duro-Test Corp.
2. General Electric Co.
3. Philips Electronics North America.
4. Radiant Lamp Co.
5. Siemens Corp.
6. Venture Lighting International Inc.
7. Substitutions: Permitted

B. Product Description: ANSI C82.4, metal halide lamp ballast, suitable for lamp and environmental conditions specified, with voltage to match luminaire voltage.

2.4 INCANDESCENT LAMPS

Manufacturers:

A. Duro-Test Corp.

B. General Electric Co.

C. Neo-Ray Products

D. Philips Electronics North America

E. RCS Industries Co.

F. Radiant Lighting

G. Substitutions: Permitted.

2.5 FLUORESCENT LAMPS

Manufacturers:

A. General Electric Co.

B. Philips Electronics North America.

C. Sylvania.

D. Or equal.

2.6 HID LAMPS

Manufacturers:

A. General Electric Co.

B. Philips Electronics North America.

C. Sylvania.

D. Or equal.

PART 3 EXECUTION

3.1 EXAMINATION

Verify foundations are ready to receive fixtures.

3.2 EXISTING WORK

A. Disconnect and remove abandoned exterior luminaires.

B. Extend existing exterior luminaire installations using materials and methods compatible with existing installations, or as specified.

C. Clean and repair existing exterior luminaires to remain or to be reinstalled.

3.3 ADJUSTING

Aim and adjust luminaires to provide illumination levels and distribution.

3.4 CLEANING

A. Clean photometric control surfaces as recommended by manufacturer.

B. Clean finishes and touch up damage.

3.5 PROTECTION OF FINISHED WORK

Relamp luminaires having failed lamps at Substantial Completion.

END OF SECTION

SECTION 16702
NEUTRAL GROUNDING RESISTORS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for supply and installation of neutral grounding resistors. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations, the Georgia Power Company requirements 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. The neutral grounding resistors specified in this section shall be installed in utility transformer neutrals which are located at the Georgia Power Company substation north of the Utoy Creek WRC as shown on the Drawings. The contractor shall supply and install the neutral grounding and concrete pads as required by the Georgia Power Company. Final connections to the neutral grounding resistors to the Georgia Power Company transformer shall be made by the Georgia Power Company.

1.2 SUBMITTALS

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

A. Product data.

B. Operation and maintenance manuals.

1.3 QUALITY STANDARDS

A. The neutral grounding resistors shall be furnished by a single manufacturer who shall assume full 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. All products covered by these specifications shall be designed, tested and constructed in accordance with the latest applicable sections of NEMA, ANSI, UL and IEEE.

B. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these specifications include:

1. General Electric.
2. Westinghouse.
3. Or equal.

PART 2 - PRODUCTS

2.1 GENERAL

Neutral grounding resistors shall be designed, manufactured and tested in compliance with IEEE 32.

2.2 RATING

The neutral grounding resistor shall have a 10-second time rating as prescribed by IEEE 32. The voltage rating shall be the line to ground voltage of the specified system voltage. The current rating shall be as specified.

2.3 CONSTRUCTION

The neutral grounding resistor shall have resistor elements which consist of edgewound helix strap wound around a ceramic core on a longitudinal stainless steel bar. The enclosure shall completely enclose the resistor and energized parts. The enclosure shall be suitable for indoor or outdoor service.

2.4 CURRENT TRANSFORMER

The resistor shall be provided with a current transformer as specified in Section 16175. The transformer ratio specified is preliminary and subject to confirmation with the coordination study in Section 16000.

2.5 TERMINAL LUGS

Terminal lugs shall be provided for copper conductors of the size specified.

2.6 NAMEPLATES

Nameplates shall be provided in accordance with the requirements of paragraph 16100-2.12.

PART 3 - EXECUTION

3.1 FIELD TESTS

The neutral grounding resistor shall be field tested accordance with Section 16999.

END OF SECTION

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SECTION 16800

ELECTRIC FREEZE PROTECTION

PART 1 - GENERAL

1.1 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 freeze protection system. 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. Section 15060, Piping and Appurtenances.
2. Section 16000, Electric Power and Systems.

1.2 SUBMITTALS

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

A. Product data.

B. Heat loss calculations for the freeze protection system, including number of circuits required, type, length and watts of each circuit, circuit breaker rating of each branch circuit, rating of main circuit breaker and size of transformer.

C. For each freeze protection system, a sketch indicating by circuit number, the piping and valves heat traced.

D. Manufacturer's installation instructions for the freeze protection system.

1.3 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:

A. American National Standards Institute (ANSI) - 515-1983, Recommended Practice for Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications
B. Underwriters laboratory (UL) - Electrical Freeze Protection Equipment

1.4 QUALITY STANDARDS

A. The freeze protection system shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been 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 freeze protection system manufacturer shall not be accepted.

D. Manufacturer's offering products that comply with these specifications include:

1. Raychem.
2. Hevi-Duty.
3. Nelson.
4. Or equal.

1.5 QUALITY CONTROL

The Contractor shall provide the services of a competent factory service engineer to supervise and coordinate the installation of the Freeze Protection System at the jobsite. The Contractor shall be completely responsible for all equipment furnished and installed as well as all information required.

1.6 SERVICE CONDITIONS

A. Altitude 850 feet above mean sea level.

Outdoors: -20^0 F to 110^0 F.

B. Type of piping to be freeze protected: FRP, stainless steel, galvanized carbon steel, copper, titanium and equipment such as valves and miscellaneous accessories.

C. Area of Classification.

Heat tracing cables and accessories shall be suitable for Class 1, Division 1, Group D, Hazardous Areas.

D. The surface temperature of the piping and components shall not exceed 139^0 F.

1.7 DESIGN AND TECHNICAL REQUIREMENTS.

General.

A. Contractor shall furnish a completely designed Freeze Protection System to prevent freezing of water or condensation in outdoor piping and equipment, and to prevent congealing, precipitation or crystallization of liquid solutions or chemicals in piping.
B. Heat tracing cable shall be secured to piping and equipment by adequate means to assure permanent thermal contact between the heaters and the equipment to be heated. Metal straps or tie wire if used shall be type 304 stainless steel.
C. Valves, flanges, instruments, or other pieces of equipment installed in a pipe line segment are heat sinks. Sufficient heat tracing cable shall be installed to offset the resulting heat losses.
D. All liquid bearing piping outside of building shall be insulated and heat traced except as shown on the Drawings.
E. The screening room, chemical room and channels are not heated and shall be treated as an outside area in this Section.
F. The tracing cable shall be the self regulating type with the insulation rated to withstand the maximum temperature of the pipe or container. In addition, the circuit breakers feeding the heat tracing cable shall be sized so that a low temperature inrush current, when calculated at 0^0 F, will be carried without overloading the wire or the circuit breaker. Acceptable types are Limitrace Type DI-HLT to 140^0 F or equal. The heat tracing cables shall be turned on by a contactor which is controlled by a thermostat. Where installation is required in hazardous areas the cable, connections and enclosures shall comply with the NEC Section 500. The heat tracing cable, connections, and connection enclosures shall be listed for installation in hazardous areas per NEC Art. 500, where so required by the plans. The limits of heat tracing of outside exposed piping shall be from the first pipe joint inside a building to a terminal point of either one foot below grade or the first pipe joint inside another building. Heat tracing for freeze protection shall be capable of maintaining a pipe temperature of 60^0 F.
G. The electric heating cable shall be tested prior to being covered with insulation. After all insulation and jacketing has been installed, the heating cable shall again be tested.

1.8 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Heat Tracing Cable.

1. The heat tracing cables shall be of the self-limiting type of adequate length with suitable allowances for all fittings, valves, and flanges.
2. The heat tracing cable construction shall be suitable for application in the above specified service environment.
3. The heat tracing cable and associated equipment shall withstand a continuous increase in the supply voltage up to 20 percent without damage or reduction of useful heater life.
4. The heat tracing cable layout shall be designed such that the connections to power supply cables occur at pipe fittings, valves, instruments, inline equipment, or other equipment locations in the piping systems. The heat tracing, as installed, shall allow for the separation of pipe flanges and the removal of valves and equipment without the removal of the adjacent heaters.
5. The make and type of heat tracing cables shall be such as to enable the monitoring of the partial or total failure of the heater circuit.
6. The heat tracing cables shall be rated for 120/208 volt, 60 Hz ac operation as required by heating circuits.
7. Each heat tracing cable shall be capable of touching and overlapping on itself while energized without any detrimental effects to itself
8. At a runaway condition, at high ambient temperature, the process liquids being freeze protected shall not exceed 100^0 F.

B. Instrument Enclosures.

1. Instruments requiring freeze protection shall be heated and insulated with heat tracing cable and thermal insulation. Allow adequate spacing for installation and removal of enclosure or insulation.
2. The enclosure shall be electrically heated and controlled from a self-contained thermostat. Thermostat may be either ambient or process controlled as required by the temperature limits of the instrument.

C. Freeze Protection Control Panel

1. The Contractor shall furnish one freeze protection control panel for power distribution, control, and monitoring of the freeze protection circuits.
2. The panel shall be designed for continuous operation suitable for the ambient temperature range as specified in SERVICE CONDITIONS.
3. All instruments and control devices required for the control of the equipment furnished by the Contractor shall be mounted within the control panel; and, wired to the terminal blocks where external cable interfacing is required. The only possible exception shall be where heated instrument enclosures are provided with integral temperature controlling thermostats.
4. The panel shall be wall mounted and shall meet the following requirements, enclosure

types shall be:
- Indoor sheltered location: NEMA 12
- Hazardous Class I/Division I: Experimental Proof
- Outdoor, corrosion area stainless steel, NEMA 4x, 316 S.S.
- Outdoor Non-corrosion minimum enclosure, 3R stainless steel 30% meeting all above requirements

The panel shall conform to the requirements as specified in SERVICE CONDITIONS.

5. The panel shall contain one ¼-inch x 1-inch solid copper ground bus of panel length, solidly bolted to panel structure. The ground bus shall be provided with one NEMA two hole ground pad for grounding with suitable ground terminals.
6. The branch circuit breakers inside the panel shall be of the thermal magnetic molded case type. The minimum interrupting rating of the circuit breakers shall be 10,000 amperes symmetrical. Circuit breakers shall be of ground fault type if the heat tracing cable does not have a metal covering per NEC Art. 427-22.
7. Lugs for incoming feeder-connectors shall be of the solderless type approved for copper connectors.
8. The panel shall have a minimum of 30 distribution and monitoring circuits. In addition, it shall have a minimum of 20 percent prewired spares for future use. Spares shall contain all necessary components for immediate use.
9. The panel shall be furnished with a main circuit breaker and a contactor of sufficient capacity to carry the load of all heating elements.

D. Circuit Monitoring
1. Each electrical heat tracing circuit shall be independently monitored for heater, continuity, heater voltage and heater current.
2. The monitoring system shall be microprocessor based and shall continuously scan all circuits.
3. The monitoring panel shall have the capacity to monitor a minimum of 36 heater circuits.
4. The monitoring system shall have the following alarm features:
   - Loss of buswire continuity
   - Loss of circuit voltage
   - Low heater current
   - Alarm silence
   - Programmable alarm delay
   - Programmable scan speed
   - Programmable circuits to be scanned
   - Auto fault reset
5. The monitoring system shall be passive, such that the system does not interfere with and is not affected by other electrical or electronic equipment.

E. Power System
Power supply to the freeze protection control panel shall be 120/208 V, 3 phase, 4-wire, 60 Hz.

F. Control System
For the freeze protection system, the contactor inside the distribution panel shall be operated by a HOA selector switch mounted on the panel door. With the selector switch in the automatic position, the contactor will be controlled by a Remote Ambient Thermostat.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Installation shall conform with the manufacturer's recommendations and as indicated on the project documents.

B. Heating elements shall be provided with termination fittings. Splicing of heating elements without a fitting or manufacturer's splicing kit will not be approved.

C. Non-terminating ends of heat trace cables shall be sealed with an end seal kit suitable for the size and type of cable used.

D. Manufacturer's recommended metallic pipe straps shall be used to secure heat trace cable to pipes.

E. Heat trace cable lengths shall be determined by contractor from the mechanical drawings.

F. All power connector boxes, thermostat and any other device boxes mounted on pipes shall be properly grounded.

G. Where traced piping enters a building, the heat trace cable or element shall extend a minimum of 12 inches inside the building.

H. Testing of heat trace system shall be performed per manufacturer's recommendations.

I. Heat transfer cement or compound and self adhesive tape, other than that supplied by the manufacturer shall not be used to secure heat trace cable.

+++ END OF SECTION +++

SECTION 16960

CONTROL CIRCUITS AND PILOT DEVICES

PART 1 - GENERAL

1.1 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 pushbutton 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 these specifications. 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.

1.2 SUBMITTALS

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

Catalog cuts, electrical ratings, adjustment ranges, enclosure types and dimensions, necessary internal and interconnection diagrams, etc.

1.3 QUALITY CRITERIA

Control devices shall comply with U.L., NEMA, and N.E.C. requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pilot devices shall generally be 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 this Division shall be as indicated on the drawings or as called for under other Sections of this Division.

PART 3 - EXECUTION

3.1 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

PART 1 - GENERAL

1.1 SCOPE

This Section includes 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.

1.2 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 Electrical Code.
   2. NEMA, National Electrical Manufacturers Association
   3. ASTM, American Society for Testing Materials.
   4. IEEE, Institute of Electrical and Electronics Engineers.
   5. NETA, National Electrical Testing Association.
   6. ANSI, American National Standards Institute.
   7. IPCEA, Insulated Power Cable Engineers Association.
   8. OSHA, Occupational Safety and Health Act.

B. Items not passing test will be rejected and shall be repaired or replaced with acceptable new items. The repaired and replacement items shall be tested.

PART 2 - PRODUCTS Not Applicable.

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. Maintain telephone or voice radio contact between the potential source location and energized remote locations during any potential testing operations.

C. Contractor shall utilize the services of a testing firm, approved by the Engineer, which is regularly engaged in the testing of electrical equipment, devices, installations and systems to conduct all of the testing

specified in this Section. The testing firm shall meet the qualification criteria set forth in NETA acceptance testing specification.

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 City'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 for each 600 V and under and 250 V DC up to 5 KV and make readings after one minute energization between each pair of poles and from each pole to the breaker frame.

C. Molded Case Circuit Breakers and Motor Circuit Protectors. Test automatic molded case circuit breakers for acceptance. Quantity to be tested is indicated below.

1. Thermomagnetic Trips. (Breakers Only). Test breakers having thermomagnetic trips in a temperature controlled environment maintained at 400 C plus or minus 30 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:
   Non Adjustable Trips - plus or minus 20% of fixed setting.
   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.

3.3 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.

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 and 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.

3.4 SPECIAL SYSTEMS

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.

3.5 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 1000 volt "Megger" or other approved 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. Perform continuity test to ensure proper cable connection.
   5. Motors: Test winding to ground.
   6. Load Side of 600 Volt Circuits: Test each phase to ground and phase to phase.
   7. Minimum Acceptable Megger Readings (Megohms at 20 C) for 600 volt class equipment:

Transformers	Megohms
Primary to ground	20
Primary to Secondary	20
Secondary to Ground	5
Services - Motor Starters and Buses	20
Motors	1
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 approved for the purpose and turned over to Engineer 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.

3.6 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. Upon receipt of written notice that the work has been completed, including tests herein specified, Engineer's representative will give the entire work a thorough inspection. Any defects or omissions noted shall be corrected before acceptance of the work.

C. The inspections and tests to be made by the Contractor 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 Engineer. Furnish a record of these tests to Engineer.

END OF SECTION

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DIVISION 17

INSTRUMENTATION AND CONTROLS

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SECTION 17000

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The Instrumentation, Control, and Monitoring (ICM) System scope of work consists of new instruments, modification of existing control panels, new control panels, field components, configuration of the existing Foxboro Distributed Control System (DCS) including the historian, and configuration of the existing Wonderware Human Machine Interface (HMI).

B. The Contractor shall procure the services of a single ICM System Supplier (Supplier) to furnish and install all materials, equipment, labor and services, except for those services and materials specifically noted, required to achieve a fully integrated and operational ICM System at East Area Water Quality Control Facility as specified herein and in other Specification Sections listed below.

C. This Section covers the general requirements for furnishing and installing the ICM system complete in every detail for the purposes specified and shall form a part of all other Sections of Division 17 unless otherwise specified. Other Sections of this Division shall supplement this Section as necessary.

1. Work Included

Furnish all tools, equipment, materials, and supplies and perform all labor required to complete the furnishing and installation of, validation, start up and operational testing of a complete and operable Instrumentation, Control and Monitoring System as indicated on the Drawings and as specified herein.

Provide all the necessary equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to ensure that the City receives a completely integrated and operational ICM as herein specified.

2. Work Not Included

Process piping, installation of in line instrumentation, i.e., final control elements in process pipelines, air compressors, main air

supply headers, and miscellaneous mechanical work as specified in other Divisions.

Electrical power distribution and signal wiring 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.

D. System Responsibility

1. Each Section in this Division shall be provided by a competent, qualified Supplier. System installation, including calibration, validation, start up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and experience. The System shall be integrated using the latest, most modern proven technology.
2. The Contractor may subcontract the work under this Division to qualified Suppliers, but 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 this Division and shall assure system uniformity, subsystem compatibility and coordination of all system interfaces, submittals, documentation, testing and training.
4. The Contractor shall determine that all components of each section are completely compatible with other required equipment, including the Foxboro DCS, and shall function as outlined, and the Contractor shall furnish and install such additional equipment, accessories, etc. as are necessary to meet these objectives at no additional cost to the City.

E. Contract Drawings

Information on the Drawings

The following information relative to the work of this Division is indicated on the Contract Drawings.

1. Location of all primary elements, cabinets, and final control elements.
2. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
3. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
4. Major instrument conduit runs.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Supplier:

a. Shall be financially sound with at least five years continuous experience in designing, implementing, supplying, and supporting instrumentation and control systems for municipal wastewater treatment facilities comparable to the instrumentation and control systems required for the project, relative to hardware, software, cost, and complexity.

b. Shall have record of successful instrumentation and control system equipment installations, including Foxboro DCS hardware installation and software configuration. Upon engineer's request, submit record of experience listing for each project: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate contract value of instrumentation and controls work for which supplier was responsible,

c. Shall have at time of bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the contract documents.

d. Shall be capable of training operations and maintenance personnel in instrumentation and control applications, and in operating, programming, and maintaining the control system and equipment.

e. Shall have UL-approved panel shop.

2. Manufacturer: manufacturers of instrumentation and control equipment furnished under this section shall be experienced producing similar equipment and shall have the following qualifications:

a. Shall manufacture instrumentation and control system components that are fully-developed, field-proven, and of standardized designs.

b. Shall have system of traceability of manufactured unit through production and testing in accordance with ANSI/ASQ Z1.4.

c. Shall have guaranteed availability clause (99.99 percent, minimum for one year) for microprocessor-based components and appurtenances.

d. Shall have documented product safety policy relevant to products proposed for the work.

B. The Contractor may subcontract the work under this Division to qualified Suppliers, but this shall not relieve the Contractor from any responsibility under the Contract.

C. The Contractor shall be responsible for the correct installation of all hardware and systems specified in this Division and shall assure system uniformity, subsystem compatibility and coordination of all system interfaces, submittals, documentation, testing and training.

D. The Contractor shall determine that all components of each section are completely compatible with other required equipment, including the Foxboro DCS, and shall function as outlined, and the Contractor shall furnish and install such additional equipment, accessories, etc. as are necessary to meet these objectives at no additional cost to the City.

1.3 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:

B. GENERAL

1. Presubmittal Conference

   Arrange a conference between the Supplier of each Section, Contractor, and the Engineer within thirty (30) days after award of the Contract for the purpose of informally discussing in detail and verifying the correctness of the Contractor's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by the Supplier's Engineer, and duly authorized representatives of the Contractor and the Engineer.

2. Draft Submittal

   Prepare a draft of the submittal for review. The draft shall include the following, as a minimum:

   a. Listing of major items proposed for this Division. 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 City if the specified item is no longer manufactured.

   b. Shop Drawings. Before proceeding with any manufacturing, submit Shop Drawings for approval 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 all equipment and tag numbers on all panels. Include material specifications lists where applicable. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

Provide five (5) copies of the following submittals:

1. Catalog Cuts

   Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under this section. 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

   Data sheets, specification sheets, and an instrument list shall be provided for all 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., complete part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number as noted in the Drawings and Specifications.

   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

   Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all differential pressure flow elements and shall include the actual scaling factors and units used.

4. Panel Construction Drawings

   Shop Drawings and Catalog Cuts

   Provide detailed shop drawings and catalog cuts for all panels, instrument racks, and enclosures. Drawings shall show the location of all front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show all major dimensions as well as elevations, in inches from the base up, of all rows of components.

   The panel legend shall list and identify all front of panel devices by their assigned tag numbers, all nameplate inscriptions, service legends, and annunciator inscriptions.

   The bill of materials shall include all devices including those 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.

5. Panel Wiring Diagrams

   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, etc.

   Provide complete terminal identification of all 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.

   All 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.

   Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show all circuits individually; no common diagrams shall be allowed.

   Provide panel power wiring diagrams for all panels. The diagrams shall include all grounding requirements.

6. Interconnecting Wiring Diagrams

   Diagrams shall show all component and Termination Cabinet identification numbers and external wire, fiber, and cable numbers. This diagram shall be coordinated with the Electrical Supplier and shall bear his mark showing that this has been done.

7. Loop Diagrams

Provide an individual wiring diagram for each analog loop showing all terminal numbers, the location of the DC power supply, signal polarity, the location of any dropping resistors, surge protection, shielding, grounding, etc. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:

Each loop diagram shall be divided into areas for identification of device locations (e.g. panel face, back of panel, field, etc.). Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11 inches by 17 inches Drawings.

8. Instrument Installation Details

The ICM Supplier 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 components.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Factory Acceptance Test Procedure:

Submit factory testing procedures that will be performed to fulfill requirements of the Contract Documents. Test procedure shall include the following:

a. Visual inspection of components and assembly.
b. Description of hardware operational testing.
c. Description of software demonstration.
d. Description of testing equipment to be used.
e. Sign-off sheets to be used at time of testing.

2. Operational Field Acceptance Test Documentation

The ICM Supplier shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

After approval of the examples, the ICM Supplier shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active I & C element (except simple hand switches, lights, etc). These sheets shall be submitted after the tests are completed.

Instrument Calibration Sheets require the ICM Supplier to 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 percent of span.
i. Explanations or special notes as applicable.
j. Date, time, and weather.
k. Tester's certification with name and signature.

3. Functional Acceptance Test Documentation

The ICM Supplier 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:

1) Project Name
2) Loop number
3) Loop description
4) Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
5) For each component: tag number, description, manufacturer, and data sheet number.
6) Space for sign off and date by the Contractor, the ICM Supplier, 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:

1) Specification page and paragraph of function demonstrated
2) Description of Function

3) Test procedure description
4) Space after each specific test to facilitate signoff on completion of each test.

1.4 TESTING

A. Factory Testing

1. Unwitnessed Factory Testing

Prior to the arrival of the Engineer, each panel shall have been completely tested by the manufacturers personnel. Provide report certifying the control panels are operable and meet the Specifications. If upon arrival of the Engineer, the panel(s) tests have not been performed, the Contractor may be liable for back charges for any extra time required by the Engineers services. The necessary panel tests shall be repeated in the presence of the Engineer; the Engineer, shall have the right to check all test observations. The ICM Supplier shall demonstrate, on a spot check basis, that the results of the unwitnessed Factory Tests are accurate. As a minimum, tests shall verify the following:

a. Location of interface wires on terminal blocks.
b. Function of discrete panel components

2. Witnessed Factory Testing

a. Inspection and test of materials and equipment may be made by the Engineer (or his representative) at the place of manufacturer prior to shipment, to verify that the completed control panel(s) meets the requirements of the specifications. Shipment shall not be made until receipt of written approval from the Engineer after satisfactory completion of shop tests.
b. The manufacturer furnishing materials, equipment and labor for the fabrication of the panel(s) shall afford the necessary facilities for such shop inspection and tests. The Contractor shall give the Engineer written notice three (3) weeks prior to the estimated date when the equipment will be ready for the inspection and witnessed shop test.
c. Sufficient time, ample space and necessary assistance shall be provided by the manufacturer to assure inspection and testing to the satisfaction of the Engineer.
d. The ICM Supplier shall furnish all power, labor, materials, and properly calibrated instruments required for the shop tests.
e. The Engineer reserves the right to reject defective materials, poor workmanship and items that do not function in accordance with the requirements of the specifications.

f. The ICM Supplier shall maintain approved copies of all design and testing related submittals at the site of testing for reference.

B. Operational Field Acceptance Testing

1. Installation Supervision

Furnish the services of authorized factory personnel specially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved Instruction Manual; (2) be present when the instruments and equipment are first put into operation; (3) inspect, check, adjust as necessary, and approve the installation; (4) calibrate the instruments, in accordance with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

2. Instrument Calibration

a. Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 10 percent, 50 percent and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 10 times greater than the specified accuracy of the instrument being calibrated.

b. Provide a list and basic specifications for instruments used for calibration.

c. Submit instrument calibration data sheet at the end of the startup. The submittal shall include all instruments furnished and installed under this contract. the data sheet shall contain instrument tag number, manufacturer part name, model number, range, scale, setpoints and date of calibration.

3. System Validation

a. Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root mean square sum of the system component published specified accuracies from input to output.

b. Validate each system by simulating inputs at the first element in loop (i.e. sensor) of 10 percent, 50 percent and 90 percent of span, or on/off and verifying other loop devices. During system validation, make provisional settings on levels, alarms, etc. Verify controllers by

observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. Verify that all logic sequences operate in accordance with the specifications.

c. Cause malfunctions to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation. Test equipment for this function shall be as specified under "Instrument Calibration."

d. Immediately correct all defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.

e. Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for calibration.

4. Contractor's Certified Reports

Upon completion of all testing, the Contractor, or his authorized representative, shall submit a certified report for each control panel and associated field instruments certifying that the equipment (1) had been properly installed under his supervision, (2) is in accurate calibration, (3) was placed in operation in his presence, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

C. Functional Acceptance Testing

1. Upon completion of instrument calibration and system validation, test all systems under actual process conditions in the presence of the Engineer. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems. This testing shall include, but not be limited to, all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and/or mechanical equipment.

2. Testing shall be observed by the Engineer. Notify the Engineer in writing a minimum of 14 days prior to the proposed date for commencing the test. Upon completion of this test the Contractor shall begin or have begun system start up. Engineer reserves the right to set the schedule.

3. Submit for approval not later than 30 days prior to the functional acceptance test demonstration, a written plan for demonstrating that each system of equipment provided under Division 13 meets the specified operational requirements.

4. The plan shall detail procedures to be used in functional acceptance testing of all systems. The plan shall include a description of test methods and materials utilized for testing each system.
5. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing.
6. Submit three copies of test results and records for all functional acceptance tests.
7. Upon completion of functional acceptance testing, submit certified report, with substantiating data sheets, indicating that total ICM System meets all the functional requirements specified herein. The Engineer will countersign this report and it shall constitute final acceptance of the ICM System.

D. System Commissioning Assistance

Provide the services of a factory trained and field experienced instrumentation engineer to assist City's personnel during startup of the system. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

E. Final Acceptance

Approved completion of the following shall constitute Final Acceptance of the ICM System.

1. Certified Functional testing Report countersigned by the Engineer.
2. Final Documentation.
3. Spares and expendables delivery.
4. Training.

1.5 OPERATION & MAINTENANCE MANUALS

A. Furnish six (6) sets of Instruction Manuals and Part Lists for instrumentation equipment provided under Division 13. Obtain distribution method instructions from the Engineer.

B. Schedule

Deliver two (2) copies of 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.

C. 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:

1. Bill of Materials

A listing of all the panels, racks, instruments, components, and devices supplied. The list may be similar to the Instrument List in the Supplements. All 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

2. Component Data Sheets

See 1.03 C.1 specified herein before.

3. Catalog Cuts

See 1.03 C.2 specified herein before.

4. Component O&M Manuals

An O&M manual shall be submitted for all 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

Detailed circuit operational description including programmable controller ladder diagrams.

5. Spare Parts and Expendables List

The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.

6. "As Shipped" Drawings

Drawings shall be a record of work "As Shipped" from the factory and shall be labeled as "As Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As Shipped" drawings as a minimum:

a. Panel Fabrication Drawings.
b. Panel Wiring, Loop, and Interconnection Drawings.

1.6 FINAL "AS INSTALLED" DOCUMENTATION

A. Reproducible Drawings

1. Contractor shall submit one (1) set of reproducibles of complete schematics, wiring diagrams and installation drawings to include all installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "AS INSTALLED". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.
2. Loop Diagrams
   See 1.3 C.7 specified herein before.
3. Panel Fabrication and Wiring diagrams
   See 1.3 C.4 and 1.02 C.5 specified herein before.
4. Interconnecting Wiring Diagrams
   See 1.3 C.6 specified herein before.
5. Instrument Installation Details
   See 1.3 C.8 herein before.

B. Process and Instrumentation Diagrams

The Engineer will supply the ICM Supplier with one set of the P&ID's for revisions to reflect the final installed system to be updated by the ICM Supplier. The ICM Supplier may use these drawings for producing the final documentation.

C. Software Documentation

In addition to the reproducible hard copy of drawings and literature generated specifically for the project, one (1) set of 3.5 inch, 1.44 meg capacity diskettes shall be submitted to the Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc using computer assisted drawing (CAD). Drawing format shall be "AutoCAD Release 11". Diskettes shall be clearly identified by the following:

1. Project Name
2. Volume Number
3. Software Program Name and Version used to generate the files.
4. Labeled "AS INSTALLED"

1.7 TRAINING REQUIREMENTS

A. General

Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of City's designated personnel in the operation of each instrument system. Obtain Engineer'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, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.

B. Maintenance Training

Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments. Manufacturer trained instruction shall be given for the following:

1. Flow Element and Transmitter, Electromagnetic (Minimum two (2) session, each of two (2) hours between class room and in field).
2. Level Element and Transmitter, Ultrasonic. (Minimum two (2) session, each of two (2) hours between class room and in field).

1.8 POST CONTRACT SYSTEM SUPPORT

Maintenance Contract

A. Duration

Provide a 1 year maintenance contract for all components furnished. The start date of one year maintenance support contract shall not begin before the final acceptance of the system.

B. Schedule

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 Engineer records of instrument verification and calibration on appropriate forms.

1.9 GUARANTEE AND WARRANTEES

Guarantee all work of Division 17 in accordance with the Conditions of Contract and Division 1. With respect to instruments and equipments, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to Engineer with City named as beneficiary.

PART 2 - PRODUCTS

2.1 HARDWARE REQUIREMENTS

A. Job Conditions

Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to overcome structural interferences. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications

Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as International Society of Automation (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities; i.e., all instruments in the plant, supplied by the Contractor, of the same type shall be by the same manufacturer. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling

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. 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, catwalks, etc. All such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in NEMA 4X cases unless otherwise noted.

E. Instrument Identification

1. All components provided under this section, both field and panel mounted, shall be provided with permanently mounted name tags

bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

2. Nameplates for panels and panel mounted equipment shall be as specified under Section 17260, Process Control Panels and Hardware.
3. Field mounted tags shall be 16 gauge, 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 all cases the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment

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 suppressor directly to the instrument, the arrestor shall be so mounted.

G. Equipment Operating Conditions

1. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
2. Power.

   Electrical. 110 Vac +/ 10%, 60 Hz +/ 1 Hz except where specifically stated otherwise on the drawings or in the specifications.

3. Field Instruments:
   a. Outdoor Areas:
      Ambient Temperature: -15ºC to +50ºC
      Ambient Relative Humidity: 5% to 100%
      Weather: Rain, wind, sun and blowing sand.
      Provide, as necessary, enclosures, and sunshields, etc. to assure normal operations under these conditions.
   b. Indoor Environmentally Uncontrolled Areas:
      Ambient Temperature: 15ºC to +50ºC
      Ambient Relative Humidity: 5% to 80%
   c. Indoor Environmentally Controlled Areas:
      Ambient Temperature: 0ºC to +50ºC
      Ambient Relative Humidity: 5% to 60%

H. Power Supplies
1. Provide electrical instruments and control devices for operation on 110 Vac, 60 Hz current.
2. 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 110 Vac, 60 Hz commercial power. Units shall be mounted within the control panels.

I. Signal Isolators, Converters and Conditioners
Insure that input output signals of all instruments and control devices (whether furnished by the Contractor or not) are compatible. Analog signals between field and panels shall be 4 to 20 mA dc unless specifically approved otherwise. Granting such approval 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
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
Provide factory paint for all instruments and equipment except where in pipelines. Provide paint as required in Division 9 for non stainless steel structural supports, brackets, etc.

L. Electrical

1. The construction work shall include all 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 all the required installations for equipment grounding as specified in Division 16 of these Specifications and indicated on the Electrical 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 City.
5. Field Wiring. For wiring materials, refer to Division 16 and Details on the Electrical Drawings. Ring out signal wiring prior to termination. Provide wire number tags marked in indelible waterproof form of slip on type heat shrink or equal for each termination.

M. Process Connections

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 Section 15060, Piping and Appurtenances, but coordinated by this Division.

N. Electrical Transient Protection

1. All instrument and control equipment mounted outside of protective structures (field mounted equipment) or that have interconnecting lines from outside the protective structure shall be equipped with suitable 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 120V ac inputs to field mounted equipment shall be secondary valve

surge protectors conforming to the requirements of IEEE Standard 28 1972 (ANSI C62.1 1971).

2. Surge and transient protectors shall be grounded according to Division 16, ELECTRICAL.
3. Field mounted protectors for signal circuits shall be Joslyn Model No. 1669 02, -06, or equal. Panel mounted protectors for signal circuits shall be Joslyn Model No. 1663-08, or equal. Protectors for 120 volt power circuits shall be Joslyn Model No. 1250 32 secondary arrestor, or equal.

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.
7. Two Total Chlorine Probes for each sampling point.
8. Two pH Electrodes for each sampling point.
9. One Flow switch for sampling point 2.
10. One Ultrasonic sensor (continuous) and transmitter for any of the two sedimentation basins.

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 17100

INSTRUMENTATION, CONTROL AND MONITORING SYSTEM LOOP DESCRIPTIONS

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes the Instrumentation, Control & Monitoring system (ICM). It is the intent of this Section to also supplement where applicable, other Sections of Division 17. It is the intent of this Section to briefly describe each main system in order that the ICM Systems Supplier (Supplier), as well as suppliers of packaged systems and subsystems shall be aware of the magnitude of the total ICM System. Certain systems described are supplied as package systems furnished under other divisions or by the City and are so identified. Interfacing with these systems is a part of the work of this Division.

B. Areas classified as Class 1, Division 1, Group D, hazardous are as indicated on the Drawings. The Contractor shall insure that all equipment and electrical circuits comply with this classification. Intrinsic safety barriers shall be furnished on all circuits that cannot be readily purchased or made to comply with requirements of Class 1, Division 1, Group D, hazardous area.

C. Related Work Specified Elsewhere
1. Division 1 General Requirements
2. Section 17200 General Requirements for Process Instrumentation Systems
3. Section 17500 Distributed Control Systems

1.2 INSTRUMENTATION AND CONTROL PHILOSOPHY

The instrumentation and control equipment for the East Area Water Quality Control Facility (EA WQCF), as described herein, is based on providing sufficient measurement, indication and/or automatic control to enable process operation within the design criteria. Automatic control loops are specified only where necessary and include manual bypass control options. Adequate monitoring equipment is specified to permit complete process operational management and evaluation and for operator protection. In general, automatic controls are confined to level, time, water quality, flow and where necessary, quality type controls. Other more sophisticated controls may be included in some packaged systems of mechanical equipment.

1.3 PROCESS INSTRUMENTATION, CONTROL & MONITORING FUNCTIONS.

A. The overall function of the Instrumentation, Control, and Monitoring System shall be to provide an efficient control and monitoring interface between plant operations and treatment processes by presenting visual and audible information of plant operating parameters, equipment status and wear, and alarm conditions. It provides automatic control of critical parameters or parameters which would require frequent operator attention. The system shall provide means for manual override operation of any automatic function when required and shall permit control of the operation of motors and valves that are pertinent to satisfactory process performance. Control and monitoring shall be accomplished locally or remotely by the Central Control and Monitoring System. The system shall provide the following described functions in accordance with the process and instrumentation diagrams ("I" Drawings).

B. Included herein are functional descriptions of the process instrumentation and control systems which specify the responsibility of the Process Instrumentation, Control & Monitoring System Supplier. These descriptions are to supplement the Process and Instrumentation Drawings and neither is complete without the other. If the Supplier

C. requires devices other than shown on the Drawings and/or specified herein to achieve the result required by the system description, provide these devices to obtain the required result.

D. The system descriptions herein cover all processes upgraded under this contract even though no specific ICM work is required in a given system. These descriptions are provided mainly for guidance during testing of the new equipment and instruments. The Supplier shall provide additional Distributed Control System (DCS) programing and Human Machine Interface (HMI) configuration which is so identified in this section. Some minor programing changes to the exiting control strategies that are not described in this section and/or are identify during testing and startup shall be performed by the Supplier at no additional cost to the city.

1.4 INPUT/OUTPUT LIST IDENTIFICATION

The Input Output (I/O) point lists contain the information necessary to configure the DCS and PLC I/O interface hardware and to indicate range conversion or signal functions.

1.5 EA WQCF FACILITY LOOP DESCRIPTIONS:

A. Sampling Point #1 Control (Influent Channel after the Vortex Separator)
   1. Drawing(s): I-003
   2. Equipment:
      a. PH Analyzer (Loop nos. 0135)
      b. Chlorine Residual Analyzer (Loop nos. 0137)

c. Plant Water Valve (HS-0138)

3. Process Overview:

a. The sampling point #1 shall collect PH and Chlorine residual information while EA-WQCF Tunnel Pumping Station is in operation. This information shall be logged in the historian along with the "Tunnel Pumping Station In Operation" status. When the Tunnel Pumping Station is not in operation, potable plant water shall be fed into the sampling tank to maintain the analytical probes wet.

b. "Tunnel Pumping Station In Operation" active status is identified when:

1) Any of the Slurry Pumps or CSO Pumps in the tunnel pump station are running.

2) Flow is measured in any of the influent flowmeters (FIT-011, FIT-012, FIT-013, FIT-014 and FIT-015)

3) The flow control valves associated with the measured flow above (FCV-011, FCV-012, FCV-013, FCV-014 and FCV-015) is open, thus directing flow to the EA-WQCF.

4) After all the above are true, there shall be a time delay only adjustable in the DCS (Initial 60 seconds).

c. "Tunnel Pumping Station In Operation" Not-active status is identified when:

1) CSO Pumps.

a). None of the CSO Pumps in the tunnel pump station is running.

b). Flow is no longer measured in any of the CSO Pumps flowmeters.

c). After all the above are true, there shall be a time delay only adjustable in the DCS (Initial 60 seconds).

2) Slurry Pumps.

a). None of the Slurry Pumps in the tunnel pump station is running.

b). And flow is no longer measured in any of the Slurry Pumps flowmeters associated to the Slurry Pumps.

c). Or flow is measured in any Slurry Pumps flowmeters but FCV-0020 is closed.

d. In automatic mode, the Potable Plant Water valve shall close when the plant is in operation and shall open when it is not in operation.

e. The Potable Plant Water valve shall be able to be controlled in manual from the DCS.

f. In case of any sort of failure of the solenoid, Potable Plant Water valve shall fail in open position to ensure water is fed into the sampling tank to maintain the analytical probes wet.

g. DCS shall monitor and indicate sampling point enclosure Temperature. Generate High and Low Temperature alarms. Setpoint should be defined during construction.

B. Sedimentation Basin Control:

1. Drawing(s): I-004 & I-005
2. Equipment:
   a. Sedimentation Basin 1:
      1) Sludge Pumps (96P3422, 96P3423, 96P3424, 96P3425).
      2) Flow Meters (FE/FIT-3461 and FE/FIT-3462).
      3) Level Transmitter (LE/LIT-3401)
      4) Plant Water Valve (FV-3431).
      5) Fluidizing Rotameters (FI-3422 to 3425).
   b. Sedimentation Basin 2:
      1) Sludge Pumps (96P3432, 96P3433, 96P3434, 96P3435).
      2) Flow Meters (FE/FIT-3471, FE/FIT-3472).
      3) Level Transmitter (LE/LIT-3411)
      4) Plant Water Valve (FV-3432).
      5) Fluidizing Rotameters (FI-3432 to 3435).
   c. Influent flowmeters (FIT-011, FIT-012, FIT-013, FIT-014 and FIT-015)
3. Process Overview:
   a. There are two Sedimentation Basins in the facility, with total of eight (8) submersible recessed impeller pumps all with equal capacity to pump sludge from the Sedimentation Basins to the existing Sludge Holding Tank for thickening. Each pump has a capacity of approximately 160 GPM at full speed and approximately 80 GPM at low speed.
   b. Each Sedimentation Basin has two cells. Each cell has two pumps that shall be set as duty/standby mode.
   c. DCS shall monitor and indicate Sludge Discharge Flow from the basin sludge pumps to sludge holding tank. Flow shall be displayed by individual meter and the total flow sum.
   d. Fluidizing water flow to each sludge pump shall be manually graduated using the needle valve and rotameter in the field. All four rotameters for each sedimentation basin shall be installed in a heated enclosure.
4. Fluidizing Water Valve Control (FV-3431 and FV-3432):
   a. Valve Actuator shall indicate “OPEN” or “CLOSED” state locally with indicating lights and at the DCS at all times.

b. Valve Actuator shall also have “LOCAL/STOP/REMOTE” and “OPEN/CLOSE” selector switches.
    1) In LOCAL, valve shall be controlled using the “OPEN/CLOSE” selector switch.
    2) In STOP, actuator shall stop and maintain the current state of the valve (open or closed).
    3) In REMOTE-AUTO, the valve control shall be performed at the DCS based on the sludge pump operation. Sludge Pump Control strategy shall ensure that respective fluidizing water valve is open before any pump is started.
    4) Fluidizing water valve can also be controlled in Remote-manual mode from the DCS screens.

5. Sedimentation Basin Sludge Pump Control:
    a. Sludge pumps shall be driven by a VFD to allow variable pumping rates based on the CSO influent flow.
    b. There are two pairs of pumps in each sedimentation basin. All four pairs shall operate in duty/standby mode and pumps within the pair shall alternate mode of operation based on operator adjustable setpoint (Initial setpoint: 12 hours).
    c. Sedimentation Basin Level for each basin shall be monitored and indicated at the DCS. If the level drops below the Low Level Setpoint (operator adjustable, initial 10 feet) and time delay set to three seconds (not adjustable), an alarm shall be generated and all running pumps in the basin shall shutoff.
    d. Emergency Stop for any pump shall prevent it from operating until it has been disengaged locally.
    e. In the event any pump reaches High temperature, pump operation shall be halted until alarm resets upon pump cooling. “High Temperature” shall be indicated locally with an indicating light and as an alarm at the DCS.
    f. Any pump fault shall be indicated locally and alarm at the DCS. Local reset button shall be required to clear faults. Any of the following may cause a fault:
        1) VFD Fail
        2) Overload
        3) High Moisture
        4) High temperature
    g. While any of the pumps is running, it’s “RUN” status shall be indicated locally with an indicating light and at the DCS.
    h. Pump speed for each pump shall be indicated at the DCS at all times.
    i. LOCAL/REMOTE selector switch:

1) In Local, the sludge pumps can be controlled via the VFD keypad using the speed knob and Start/Stop pushbuttons.
2) In Remote, the pump control is available at the DCS.

j. Remote Manual Mode: The sludge pumps can be controlled via the HMI screens using the speed control entry and soft Start/Stop pushbuttons.

k. Remote Auto Mode: The sludge pumps shall be controlled by the DCS as follows:
1) The duty Sludge pump in each cell shall start when there is a wet weather event or the plant is "in operation", and the collector has been running for at least one complete cycle plus an adjustable time delay (Initial value 10 minutes).
2) Pump Speed shall be calculated at the DCS based on the total influent flow rate from the influent flow meters. Minimum pump speed setpoint (operator adjustable, initial value 60%) shall be set when influent flow is at the Minimum Plant Flow setpoint (operator adjustable, initial value 5 MGD). From there onwards speed shall increase proportionally to keep up with the increasing influent flow. Maximum pump speed (operator adjustable. Initial value 100%) shall be set when the maximum Plant Flow setpoint is reached (operator adjustable, initial value 20 MGD).
3) In the event that duty pump fails, standby pump shall take over and respond to the DCS control.
4) Sludge Pump shall stop when collector stops running and after a time delay (operator adjustable, initial value 5 minutes).

C. Sampling Point #2 Control (Filters Building)
1. Drawing(s): I-008
2. Equipment:
a. PH Analyzer (Loop nos. 0908)
b. Chlorine Residual Analyzer (Loop nos. 0910)
c. Filters Effluent Channel High Level (LIH-0904)
d. Plant Water Valve (HS-0911)
3. Process Overview:
a. The sampling point #2 shall collect PH and Chlorine residual information while there is flow in the filters effluent channel. This information shall be logged in the historian along with the "Sampling Point #2" status. When the Sampling Point #2 is not active, potable plant water

shall be fed into the sampling tank to maintain the analytical probes wet.

b. Sampling Point #2 status is defined by the filters effluent channel high level indication. If water level is present as measured by LSH-0914 and after a Non-adjustable time delay (Initial 3 secs), the Sampling Point #2 is active. Sampling Point #2 shall deactivate when no water level in the filter effluent channel is detected and after an adjustable time delay (Initial 5 seconds).

c. In automatic mode, the potable plant water valve shall close when the Sampling Point #2 is in operation and shall open when it is not in operation.

d. The Potable Plant water valve shall be able to be controlled in manual from the DCS.

e. In case of any sort of failure of the solenoid, Potable Plant Water valve shall fail in open position to ensure water is fed into the sampling tank to maintain the analytical probes wet.

f. DCS shall indicate pH and Total Chlorine Residual of the sample.

g. Sampling Pumps Control:

1) Hand Mode: If the H/O/A selector switch on the control panel is on HAND, the pump shall run.

2) If the H/O/A selector switch on the control panel is on OFF, the pump shall not run.

3) If the H/O/A selector switch on the control panel is on AUTO, the pumps shall operate in Duty/Standby mode.

a. Duty Pump shall run when Sampling Point #2 is active.

b. If flow is not detected and after a time delay (initial 5 seconds), it shall be assumed that duty sampling pump is not functional and standby pump shall takeover. A sampling pump malfunction alarm shall be generated.

c. If flow is not detected again after a time delay (initial 10 seconds), a sampling station malfunction alarm shall be generated

D. Sludge Holding Tank Control

1. Drawing(s): I-017

2. Equipment:

a. Sludge Holding Tank (81T3501)

b. Sludge Holding Tank Level (LE/LIT-3502)

3. Process Overview:

a. Level in the sludge holding tank shall be monitored and indicated at the DCS.

b. New thickening mechanism shall be installed in the existing sludge holding tank, which shall operate continuously whenever the sludge holding tank is receiving sludge flow from the sedimentation basins.

c. Local Control Panel (LCP) for the thickener mechanism shall be located on the service bridge of the sludge holding tank. LCP shall have a strobe to indicate any kind of fault condition. VFD for the thickener shall be located in the dewatering building electrical room.

d. All the signals related to the Sludge Holding Tank are wired to the Belt Filter Press control panel (CP-BFP). The Foxboro DCS shall communicate with the CP-BFP using Ethernet IP over fiber optic link to monitor and control the Sludge Holding Tank.

4. Thickener Drive Control:

a. Thickener Drive shall operate in auto or manual mode.

b. Emergency Stop (HS-3501) at LCP shall stop and prevent thickener operation in any mode until E-stop has been disengaged locally.

c. High Torque alarms.

1) When a high drive torque (85 percent of maximum running torque) is sensed, a warning signal shall be transmitted to the DCS system for alarming.

2) When a high-high drive torque (100 percent of the maximum running torque) is sensed, VFD shall shutdown the drive and send signal to the DCS for alarming. An over-torque alarm light on the LCP shall indicate the alarm shutdown. Further operation of the mechanism will require manual reset of the lockout relay within the LCP by pressing the LCP Reset push button.

d. The following alarms shall shutdown the Thickener Drive and will required local reset:

1) Overload
2) Emergency Stop
3) VFD Fail
4) High motor Winding Temperature Alarm

e. LCP shall be provided with LOCAL/OFF/REMOTE (L/O/R) selector switch.

1) In Local, thickener shall be controlled locally from the LCP with Start/Stop push button (PB-3501) and Speed Control Switch (SC-3501).

2) In Off, drive operation shall be prevented in any mode.

3) In Remote, the drive control is available at the DCS. Speed control shall be entered by the operator in

ether manual or auto mode. Speed control shall be clamped to lower (initial value 60%) and upper (initial value 90%) limits. Final limits shall be defined during startup.

a. In Remote-Manual, operator shall use Start/Stop soft pushbuttons to control the Thickener Drive.

b. In Remote-Automatic, DCS shall start the drive once the level in the holding tank exceeds operator adjustable setpoint (initial value 1ft) and after a time delay (Initial value 3 seconds). DCS shall stop the drive once the sludge level in the holding tank falls below operator adjustable setpoint (initial value 0.8ft) plus a time delay (initial 3 seconds).

E. Belt Filter Press Feed Pumps and Grinders

1. Drawing(s): I-018
2. Equipment:
   a. Sludge Feed Pump No. 1 (82P3602)
   b. Sludge Feed Pump No. 2 (82P3604)
   c. Sludge Feed Grinder No. 1 (82G3612)
   d. Sludge Feed Grinder No. 2 (82G3614)
3. Process Overview:
   a. CP-BFP via Remote I/O shall control and monitor all the equipment above as outlined in specification Section 11521, Belt Filter Press.
   b. CP-BFP Remote I/O shall be connected to CP-BFP PLC and OIT in a Ring topology via Ethernet IP. CP-BFP and CP-BFP-RIO panels will communicate using Ethernet IP protocol over a fiber optic link.
   c. The Foxboro DCS will communicate with the CP-BFP using Ethernet IP protocol over a fiber optic link. The DCS will monitor all the signals as shown in the Input Output list and as specified in specification Section 11521, Belt Filter Press.
   d. The DCS will write the necessary data to synchronize date and time in the CP-BFP every day at 4:00 AM. Coordinate the list of necessary points with the Belt Filter Press supplier.

F. Belt Filter Press Control

1. Drawing(s): I-017and I-019
2. Equipment:
   a. Polymer System (83POLY3701)
   b. Belt Filter Press (83BFP3720)

c. Booster Pump (83P3720)
d. Belt Conveyor (83CON3730)

3. Process Overview:
   a. CP-BFP shall control and monitor all the processes above as outlined in specification Section 11521, Belt Filter Press.
   b. The Foxboro DCS will communicate with the CP-BFP using Ethernet IP protocol over a fiber optic link. The DCS will monitor all the signals as shown in the Input Output list and as specified in specification Section 11521, Belt Filter Press.
   c. The DCS will write the necessary data to synchronize date and time in the CP-BFP every day at 4:00 AM. Coordinate the list of necessary points with the Belt Filter Press supplier.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SUPPLEMENTS

A. The supplements listed below, following the "End of Section 17100" designation, are part of this Specification section.

B. Input/Output List

END OF SECTION

INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	SIGNAL FROM DEVICE	SIGNAL TO DEVICE
CSO CHEMICAL FACILITY CONTROL PANEL (CP-CF)					
95-AI-0135	SAMPLING STATION NO.1 PH	I-003	AI	AIT-0137	CP-CF
95-AI-0137	SAMPLING STATION NO.1 CHLORINE RESIDUAL	I-003	AI	AIT-0137	CP-CF
95-PSL-0135	SAMPLING STATION NO.1 LOW PRESSURE	I-003	AI	PSL-0135	CP-CF
95-YN-0138	SAMPLING STATION NO.1 PLANT WATER VALVE IN AUTO	I-003	DI	SAMPLING STATION NO.1 CP	CP-CF
95-ZH-0138	SAMPLING STATION NO.1 PLANT WATER VALVE OPEN	I-003	DI	SAMPLING STATION NO.1 CP	CP-CF
95-ZL-0138	SAMPLING STATION NO.1 PLANT WATER VALVE CLOSED	I-003	DI	SAMPLING STATION NO.1 CP	CP-CF
95-HS-0133	SAMPLING STATION NO.1 SAMPLING PUMP 1 START/STOP	I-003	DO	CP-FB	SAMPLING STATION NO.1 CP
95-HS-0134	SAMPLING STATION NO.1 SAMPLING PUMP 2 START/STOP	I-003	DO	CP-FB	SAMPLING STATION NO.1 CP
95-YN-0133	SAMPLING STATION NO.1 SAMPLING PUMP 1 IN AUTO	I-003	DI	SAMPLING STATION NO.1 CP	CP-FB
95-YN-0134	SAMPLING STATION NO.1 SAMPLING PUMP 2 IN AUTO	I-003	DI	SAMPLING STATION NO.1 CP	CP-FB
95-XA-0140	SAMPLING STATION NO.1 UPS FAULT	I-003	DI	UPS	CP-CF
CSO SLUDGE PUMP STATION CONTROL PANEL (CP-SP)					
96-YN-3431	PLANT WATER VALVE FV-3431 READY IN AUTO	I-004	DI	FV-3431	CP-SP
96-HS-3431	PLANT WATER VALVE FV-3431 OPEN/CLOSE COMMAND	I-004	DO	CP-SP	FV-3431
96-ZL-3431	PLANT WATER VALVE FV-3431 OPENED	I-004	DI	FV-3431	CP-SP
96-ZH-3431	PLANT WATER VALVE FV-3431 CLOSED	I-004	DI	FV-3431	CP-SP
96-LI-3401	SEDIMENTATION BASIN NO.1 LEVEL	I-004	AI	LIT-3401	CP-SP
96-SI-3422	SLUDGE PUMP 96P3422 SPEED FEEDBACK	I-004	AI	96P3422 VFD	CP-SP
96-YN-3422	SLUDGE PUMP 96P3422 IN REMOTE	I-004	DI	96P3422 VFD	CP-SP
96-XA-3422	SLUDGE PUMP 96P3422 FAULT	I-004	DI	96P3422 VFD	CP-SP
96-MC-3422	SLUDGE PUMP 96P3422 START/STOP	I-004	DO	CP-SP	96P3422 VFD
96-SC-3422	SLUDGE PUMP 96P3422 SPEED COMMAND	I-004	AO	CP-SP	96P3422 VFD
96-MN-3422	SLUDGE PUMP 96P3422 RUNNING	I-004	DI	96P3422 VFD	CP-SP
96-SI-3423	SLUDGE PUMP 96P3423 SPEED FEEDBACK	I-004	AI	96P3423 VFD	CP-SP
96-YN-3423	SLUDGE PUMP 96P3423 IN REMOTE	I-004	DI	96P3423 VFD	CP-SP
96-XA-3423	SLUDGE PUMP 96P3423 FAULT	I-004	DI	96P3423 VFD	CP-SP
96-MC-3423	SLUDGE PUMP 96P3423 START/STOP	I-004	DO	CP-SP	96P3423 VFD
96-SC-3423	SLUDGE PUMP 96P3423 SPEED COMMAND	I-004	AO	CP-SP	96P3423 VFD
96-MN-3423	SLUDGE PUMP 96P3423 RUNNING	I-004	DI	96P3423 VFD	CP-SP
96-FI-3462	SLUDGE PUMPS 96P3422 / 96P3423 FLOW	I-004	AI	FIT-3462	CP-SP
96-SI-3424	SLUDGE PUMP 96P3424 SPEED FEEDBACK	I-004	AI	96P3424 VFD	CP-SP
96-YN-3424	SLUDGE PUMP 96P3424 IN REMOTE	I-004	DI	96P3424 VFD	CP-SP
96-XA-3424	SLUDGE PUMP 96P3424 FAULT	I-004	DI	96P3424 VFD	CP-SP
96-MC-3424	SLUDGE PUMP 96P3424 START/STOP	I-004	DO	CP-SP	96P3424 VFD
96-SC-3424	SLUDGE PUMP 96P3424 SPEED COMMAND	I-004	AO	CP-SP	96P3424 VFD
96-MN-3424	SLUDGE PUMP 96P3424 RUNNING	I-004	DI	96P3424 VFD	CP-SP
96-SI-3425	SLUDGE PUMP 96P3425 SPEED FEEDBACK	I-004	AI	96P3425 VFD	CP-SP
96-YN-3425	SLUDGE PUMP 96P3425 IN REMOTE	I-004	DI	96P3425 VFD	CP-SP
96-XA-3425	SLUDGE PUMP 96P3425 FAULT	I-004	DI	96P3425 VFD	CP-SP
96-MC-3425	SLUDGE PUMP 96P3425 START/STOP	I-004	DO	CP-SP	96P3425 VFD
96-SC-3425	SLUDGE PUMP 96P3425 SPEED COMMAND	I-004	AO	CP-SP	96P3425 VFD
96-MN-3425	SLUDGE PUMP 96P3425 RUNNING	I-004	DI	96P3425 VFD	CP-SP
96-FI-3461	SLUDGE PUMPS 96P3424 / 96P3425 FLOW	I-004	AI	FIT-3461	CP-SP
96-YN-3481	SLUDGE COLLECTOR 96COL3213 ON	I-004	DI	MC-3481	CP-SP
96-WA-3481	SLUDGE COLLECTOR 96COL3213 HIGH TORQUE_FAULT	I-004	DI	MC-3481	CP-SP
96-MN-3481	SLUDGE COLLECTOR 96COL3213 RUN	I-004	DI	MC-3481	CP-SP
96-XA-3481	SLUDGE COLLECTOR 96COL3213 FAULT	I-004	DI	MC-3481	CP-SP
96-YN-3482	SLUDGE COLLECTOR 96COL3214 ON	I-004	DI	MC-3482	CP-SP
96-WA-3482	SLUDGE COLLECTOR 96COL3214 HIGH TORQUE FAULT	I-004	DI	MC-3482	CP-SP
96-MN-3482	SLUDGE COLLECTOR 96COL3214 RUN	I-004	DI	MC-3482	CP-SP
96-XA-3482	SLUDGE COLLECTOR 96COL3214 FAULT	I-004	DI	MC-3482	CP-SP
96-YN-3441	PLANT WATER VALVE FV-3432 LOCAL/REMOTE	I-005	DI	FV-3441	CP-SP
96-HS-3441	PLANT WATER VALVE FV-3432 OPEN/CLOSE COMMAND	I-005	DO	CP-SP	FV-3441
96-ZL-3441	PLANT WATER VALVE FV-3432 OPENED	I-005	DI	FV-3441	CP-SP
96-ZH-3441	PLANT WATER VALVE FV-3432 CLOSED	I-005	DI	FV-3441	CP-SP
96-LI-3411	SEDIMENTATION BASIN NO.2 LEVEL	I-005	AI	LIT-3411	CP-SP
96-SI-3432	SLUDGE PUMP 96P3432 SPEED FEEDBACK	I-005	AI	96P3432 VFD	CP-SP
96-YN-3432	SLUDGE PUMP 96P3432 IN REMOTE	I-005	DI	96P3432 VFD	CP-SP
96-XA-3432	SLUDGE PUMP 96P3432 FAULT	I-005	DI	96P3432 VFD	CP-SP
96-MC-3432	SLUDGE PUMP 96P3432 START/STOP	I-005	DO	CP-SP	96P3432 VFD
96-SC-3432	SLUDGE PUMP 96P3432 SPEED COMMAND	I-005	AO	CP-SP	96P3432 VFD
96-MN-3432	SLUDGE PUMP 96P3432 RUNNING	I-005	DI	96P3432 VFD	CP-SP
96-SI-3433	SLUDGE PUMP 96P3433 SPEED FEEDBACK	I-005	AI	96P3433 VFD	CP-SP
96-YN-3433	SLUDGE PUMP 96P3433 IN REMOTE	I-005	DI	96P3433 VFD	CP-SP
96-XA-3433	SLUDGE PUMP 96P3433 FAULT	I-005	DI	96P3433 VFD	CP-SP
96-MC-3433	SLUDGE PUMP 96P3433 START/STOP	I-005	DO	CP-SP	96P3433 VFD

INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	SIGNAL FROM DEVICE	SIGNAL TO DEVICE
96-SC-3433	SLUDGE PUMP 96P3433 SPEED COMMAND	I-005	AO	CP-SP	96P3433 VFD
96-MN-3433	SLUDGE PUMP 96P3433 RUNNING	I-005	DI	96P3433 VFD	CP-SP
96-FI-3472	SLUDGE PUMPS 96P3432 / 96P3433 FLOW	I-005	AI	FIT-3472	CP-SP
96-SI-3434	SLUDGE PUMP 96P3434 SPEED FEEDBACK	I-005	AI	96P3434 VFD	CP-SP
96-YN-3434	SLUDGE PUMP 96P3434 IN REMOTE	I-005	DI	96P3434 VFD	CP-SP
96-XA-3434	SLUDGE PUMP 96P3434 FAULT	I-005	DI	96P3434 VFD	CP-SP
96-MC-3434	SLUDGE PUMP 96P3434 START/STOP	I-005	DO	CP-SP	96P3434 VFD
96-SC-3434	SLUDGE PUMP 96P3434 SPEED COMMAND	I-005	AO	CP-SP	96P3434 VFD
96-MN-3434	SLUDGE PUMP 96P3434 RUNNING	I-005	DI	96P3434 VFD	CP-SP
96-SI-3435	SLUDGE PUMP 96P3435 SPEED FEEDBACK	I-005	AI	96P3435 VFD	CP-SP
96-YN-3435	SLUDGE PUMP 96P3435 IN REMOTE	I-005	DI	96P3435 VFD	CP-SP
96-XA-3435	SLUDGE PUMP 96P3435 FAULT	I-005	DI	96P3435 VFD	CP-SP
96-MC-3435	SLUDGE PUMP 96P3435 START/STOP	I-005	DO	CP-SP	96P3435 VFD
96-SC-3435	SLUDGE PUMP 96P3435 SPEED COMMAND	I-005	AO	CP-SP	96P3435 VFD
96-MN-3435	SLUDGE PUMP 96P3435 RUNNING	I-005	DI	96P3435 VFD	CP-SP
96-FI-3471	SLUDGE PUMPS 96P3434 / 96P3435 FLOW	I-005	AI	FIT-3471	CP-SP
96-YN-3491	SLUDGE COLLECTOR 96COL3219 ON	I-005	DI	MC-3491	CP-SP
96-WA-3491	SLUDGE COLLECTOR 96COL3219 HIGH TORQUE FAULT	I-005	DI	MC-3491	CP-SP
96-MN-3491	SLUDGE COLLECTOR 96COL3219 RUN	I-005	DI	MC-3491	CP-SP
96-XA-3491	SLUDGE COLLECTOR 96COL3219 FAULT	I-005	DI	MC-3491	CP-SP
96-YN-3492	SLUDGE COLLECTOR 96COL3220 ON	I-005	DI	MC-3492	CP-SP
96-WA-3492	SLUDGE COLLECTOR 96COL3220 HIGH TORQUE FAULT	I-005	DI	MC-3492	CP-SP
96-MN-3492	SLUDGE COLLECTOR 96COL3220 RUN	I-005	DI	MC-3492	CP-SP
96-XA-3492	SLUDGE COLLECTOR 96COL3220 FAULT	I-005	DI	MC-3492	CP-SP
FILTER BUILDING CONTROL PANEL (CP-FB)					
97-LAL-0904	FILTER EFFLUENT CHANNEL LEVEL LOW	I-008	DI	LSL-0904	CP-FB
97-HS-0914	SAMPLING STATION NO.2 SAMPLING PUMP 1 START/STOP	I-008	DO	CP-FB	SAMPLING STATION NO.2 CP
97-HS-0915	SAMPLING STATION NO.2 SAMPLING PUMP 2 START/STOP	I-008	DO	CP-FB	SAMPLING STATION NO.2 CP
97-YN-0914	SAMPLING STATION NO.2 SAMPLING PUMP 1 IN AUTO	I-008	DI	SAMPLING STATION NO.2 CP	CP-FB
97-YN-0915	SAMPLING STATION NO.2 SAMPLING PUMP 2 IN AUTO	I-008	DI	SAMPLING STATION NO.2 CP	CP-FB
97-AI-0908	SAMPLING STATION NO.2 PH	I-008	AI	AIT-0910	CP-FB
97-AI-0910	SAMPLING STATION NO.2 CHLORINE RESIDUAL	I-008	AI	AIT-0910	CP-FB
97-YN-0911	SAMPLING STATION NO.2 PLANT WATER VALVE IN AUTO	I-008	DI	SAMPLING STATION NO.2 CP	CP-FB
97-ZH-0911	SAMPLING STATION NO.2 PLANT WATER VALVE OPEN	I-008	DI	SAMPLING STATION NO.2 CP	CP-FB
97-ZL-0911	SAMPLING STATION NO.2 PLANT WATER VALVE CLOSED	I-008	DI	SAMPLING STATION NO.2 CP	CP-FB
97-PSL-0912	SAMPLING STATION NO.2 LOW PRESSURE	I-008	DI	PSL-0912	CP-FB
97-XA-0913	SAMPLING STATION NO.2 UPS FAULT	I-008	DI	UPS	CP-FB
ADMINISTRATION BUILDING MAIN CONTROL PANEL (MCP)					
81-SI-3501	SLUDGE HOLDING TANK DRIVE SPEED FEEDBACK	I-017	ETH	CP-BFP	MCP
81-SC-3501	SLUDGE HOLDING TANK DRIVE SPEED COMMAND	I-017	ETH	MCP	CP-BFP
81-HS-3501	SLUDGE HOLDING TANK DRIVE START/STOP	I-017	ETH	MCP	CP-BFP
81-YN-3501	SLUDGE HOLDING TANK DRIVE IN REMOTE	I-017	ETH	CP-BFP	MCP
81-IA-3501	SLUDGE HOLDING TANK DRIVE OVERLOAD	I-017	ETH	CP-BFP	MCP
81-YN-3501B	SLUDGE HOLDING TANK DRIVE E-STOP	I-017	ETH	CP-BFP	MCP
81-XA-3501B	SLUDGE HOLDING TANK DRIVE VFD FAIL	I-017	ETH	CP-BFP	MCP
81-MN-3501	SLUDGE HOLDING TANK DRIVE RUNNING	I-017	ETH	CP-BFP	MCP
81-XA-3501C	SLUDGE HOLDING TANK DRIVE TORQUE WARNING	I-017	ETH	CP-BFP	MCP
81-XA-3501D	SLUDGE HOLDING TANK DRIVE TORQUE ALARM	I-017	ETH	CP-BFP	MCP
81-XA-3501E	SLUDGE HOLDING TANK DRIVE HIGH WINDING TEMPERATURE	I-017	ETH	CP-BFP	MCP
81-LI-3502	SLUDGE HOLDING TANK LEVEL	I-017	ETH	CP-BFP	MCP
82-UA-3612A	SLUDE FEED GRINDER 1 OVERLOAD	I-017	ETH	CP-BFP	MCP
82-UA-3612B	SLUDE FEED GRINDER 1 JAMMED	I-017	ETH	CP-BFP	MCP
82-MN-3612	SLUDE FEED GRINDER 1 RUNNING	I-017	ETH	CP-BFP	MCP
82-YN-3612	SLUDE FEED GRINDER 1 IN REMOTE	I-017	ETH	CP-BFP	MCP
82-SI-3602	SLUDE FEED PUMP 1 SPEED FEEDBACK	I-017	ETH	CP-BFP	MCP
82-MN-3602	SLUDE FEED PUMP 1 RUNNING	I-017	ETH	CP-BFP	MCP
82-YN-3602	SLUDE FEED PUMP 1 IN REMOTE	I-017	ETH	CP-BFP	MCP
82-UA-3602B	SLUDE FEED PUMP 1 OVERLOAD	I-017	ETH	CP-BFP	MCP
82-PAH-3602	SLUDE FEED PUMP 1 HIGH PRESSURE	I-017	ETH	CP-BFP	MCP
82-PAL-3602	SLUDE FEED PUMP 1 LOW PRESSURE	I-017	ETH	CP-BFP	MCP
82-UA-3602A	SLUDE FEED PUMP 1 E-STOP	I-017	ETH	CP-BFP	MCP
82-UA-3602C	SLUDE FEED PUMP 1 VFD FAIL	I-017	ETH	CP-BFP	MCP
82-UA-3614A	SLUDE FEED GRINDER 2 OVERLOAD	I-017	ETH	CP-BFP	MCP
82-UA-3614B	SLUDE FEED GRINDER 2 JAMMED	I-017	ETH	CP-BFP	MCP
82-MN-3614	SLUDE FEED GRINDER 2 RUNNING	I-017	ETH	CP-BFP	MCP
82-YN-3614	SLUDE FEED GRINDER 2 IN REMOTE	I-017	ETH	CP-BFP	MCP
82-SI-3604	SLUDE FEED PUMP 2 SPEED FEEDBACK	I-017	ETH	CP-BFP	MCP

INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	SIGNAL FROM DEVICE	SIGNAL TO DEVICE
82-MN-3604	SLUDE FEED PUMP 2 RUNNING	I-017	ETH	CP-BFP	MCP
82-YN-3604	SLUDE FEED PUMP 2 IN REMOTE	I-017	ETH	CP-BFP	MCP
82-UA-3604B	SLUDE FEED PUMP 2 OVERLOAD	I-017	ETH	CP-BFP	MCP
82-PAH-3604	SLUDE FEED PUMP 2 HIGH PRESSURE	I-017	ETH	CP-BFP	MCP
82-PAL-3604	SLUDE FEED PUMP 2 LOW PRESSURE	I-017	ETH	CP-BFP	MCP
82-UA-3604A	SLUDE FEED PUMP 2 E-STOP	I-017	ETH	CP-BFP	MCP
82-UA-3604C	SLUDE FEED PUMP 2 VFD FAIL	I-017	ETH	CP-BFP	MCP
83-FI-3710	SLUDGE FEED FLOW	I-019	ETH	CP-BFP	MCP
83-MN-3701	POLYMER SYSTEM RUNNING	I-019	ETH	CP-BFP	MCP
83-XA-3701	POLYMER SYSTEM FAIL	I-019	ETH	CP-BFP	MCP
83-SI-3701	POLYMER SYSTEM SPEED FEEDBACK	I-019	ETH	CP-BFP	MCP
83-YA-3701	POLYMER SYSTEM IN REMOTE	I-019	ETH	CP-BFP	MCP
83-FI-3701	POLYMER SYSTEM FLOW	I-019	ETH	CP-BFP	MCP
83-MN-3720	BELT FILTER PRESS HYDRAULIC PUMP RUNNING	I-019	ETH	CP-BFP	MCP
83-YL-3720	BELT FILTER PRESS HYDRAULIC PUMP NOT RUNNING	I-019	ETH	CP-BFP	MCP
83-PAL-3720	BELT FILTER PRESS HYDRAULIC PUMP LOW HYDRAULIC PRESSURE	I-019	ETH	CP-BFP	MCP
83-ZL-3720	WASHWATER VALVE OPENED INDICATION	I-019	ETH	CP-BFP	MCP
83-ZH-3720	WASHWATER VALVE CLOSED INDICATION	I-019	ETH	CP-BFP	MCP
83-MN-3720B	WASHWATER PUMP RUNNING	I-019	ETH	CP-BFP	MCP
83-YL-3720B	WASHWATER PUMP NOT RUNNING	I-019	ETH	CP-BFP	MCP
83-UA-3720	WASHWATER VALVE OPENED ALARM	I-019	ETH	CP-BFP	MCP
83-UA-3720B	WASHWATER VALVE CLOSED ALARM	I-019	ETH	CP-BFP	MCP
83-PAL-3720B	LOW WATER PRESSURE	I-019	ETH	CP-BFP	MCP
83-MN-3720C	BFP CONVEYOR RUNNING	I-019	ETH	CP-BFP	MCP
83-YL-3720C	BFP IN JOG MODE	I-019	ETH	CP-BFP	MCP
83-YA-3720	BFP READY	I-019	ETH	CP-BFP	MCP
83-MC-3720	BFP ONLINE (PRE-WASH)	I-019	ETH	CP-BFP	MCP
83-MC-3720B	BFP ONLINE (RUNNING)	I-019	ETH	CP-BFP	MCP
83-MC-3720C	BFP ONLINE (POST-WASH)	I-019	ETH	CP-BFP	MCP
83-MC-3720D	BFP ONLINE (DISCHARGING)	I-019	ETH	CP-BFP	MCP
83-XA-3720E	BFP IN ALARM	I-019	ETH	CP-BFP	MCP
83-UA-3720C	BFP EMERGENCY STOP	I-019	ETH	CP-BFP	MCP
83-UA-3720D	BFP BELT MISALIGNMENT	I-019	ETH	CP-BFP	MCP
83-FAL-3720	BFP LOW SLUDGE FEED FLOW	I-019	ETH	CP-BFP	MCP
83-MN-3720D	BELT DRIVE RUNNING INDICATION	I-019	ETH	CP-BFP	MCP
83-XA-3720	BELT DRIVE OVERTEMPERATURE	I-019	ETH	CP-BFP	MCP
83-SI-3720	BELT DRIVE SPEED INDICATION	I-019	ETH	CP-BFP	MCP
83-XA-3720B	PRESSURE BELT BROKEN (UPPER)	I-019	ETH	CP-BFP	MCP
83-XA-3720C	PRESSURE BELT BROKEN (LOWER)	I-019	ETH	CP-BFP	MCP
83-MC-3720E	BELT DRIVE NOT RUNNING	I-019	ETH	CP-BFP	MCP
83-YL-3720D	BELT CONVEYOR NOT RUNNING	I-019	ETH	CP-BFP	MCP
83-SIL-3720	BELT CONVEYOR SPEED SWITCH LOW	I-019	ETH	CP-BFP	MCP
83-XA-3720D	BELT CONVEYOR EMERGENCY TRIP ROPE	I-019	ETH	CP-BFP	MCP
83-UA-3730	BELT CONVEYOR MISALIGNMENT	I-019	ETH	CP-BFP	MCP
83-SI-3730	BELT CONVEYOR ZERO SPEED	I-019	ETH	CP-BFP	MCP
83-YA-3730	BELT CONVEYOR E-STOP	I-019	ETH	CP-BFP	MCP
83-MN-3730	BELT CONVEYOR RUNNING	I-019	ETH	CP-BFP	MCP
83-YN-3730	BELT CONVEYOR IN REMOTE	I-019	ETH	CP-BFP	MCP
83-XA-3730	BELT CONVEYOR OVERLOAD	I-019	ETH	CP-BFP	MCP
83-YA-3730B	BELT CONVEYOR PULL CORD	I-019	ETH	CP-BFP	MCP
	CP-BFP SURGE SUPPRESSOR BLOWN		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 2		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 3		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 4		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 5		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 6		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 7		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 8		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 9		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 10		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 11		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 12		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 13		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 14		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 15		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 16		ETH	CP-BFP	MCP
	SPARE CONSUME TAG 17		ETH	CP-BFP	MCP

INPUT-OUTPUT LIST

TAG	DESCRIPTION	DRAWING NO.	SIGNAL TYPE	SIGNAL FROM DEVICE	SIGNAL TO DEVICE
	SYNCHRONIZE DAY OF THE WEEK		ETH	MCP	CP-BFP
	SYNCHRONIZE YEAR		ETH	MCP	CP-BFP
	SYNCHRONIZE MONTH		ETH	MCP	CP-BFP
	SYNCHRONIZE DATE		ETH	MCP	CP-BFP
	SYNCHRONIZE HOUR		ETH	MCP	CP-BFP
	SYNCHRONIZE MINUTE		ETH	MCP	CP-BFP
	SYNCHRONIZE SECOND		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 1		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 2		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 3		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 4		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 5		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 6		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 7		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 8		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 9		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 10		ETH	MCP	CP-BFP
	SPARE PRODUCE TAG 11		ETH	MCP	CP-BFP

SECTION 17211

PROCESS TAPS AND PRIMARY ELEMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section specifies general requirements which are applicable to all process instrumentation systems consisting of process sensors, monitoring and control instruments, and accessories required to provide a complete and functional monitoring and control system.

B. Work Included:

1. The Contractor shall provide, calibrate, and test the complete process instrumentation system. The Contractor shall also place the completed system in operation including tuning loops and make final adjustments to instruments as required during plant start-up. The Contractor shall provide the services of instrument technicians for testing and adjustment activities.
2. The Contractor shall examine the mechanical drawings and specifications to determine actual locations, sizes, materials and ratings of process connections.

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 considered as being included in the price bid for the work shown and specified.

D. Operating Requirements:
The devices specified in this section quantitatively convert the measured variable energy into a form suitable for measurement and process measurement accessories.

E. Related Work Specified Elsewhere:
Division 1 General Requirements

1.2 SUBMITTALS

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

A. Flow calculation for each differential-type flow element.

B. In accordance with paragraph 17000 1.3 D, record documentation shall include the data sheets specified in this section.

C. Data sheets for all instruments and accessories to be provided. Data sheets shall be in accordance with ISA-20. All applicable entries on the data sheet shall be completed.

1.3 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

B. Manufacturer:
Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:
Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

D. References:
References are listed in Section 17000. They are a part of this section as specified and modified.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION SPECIFICATION DATA SHEETS (INSTRUSPEC)

Specific requirements for instruments included in this section are listed on INSTRUSPEC sheets in paragraph 3.3 of this section. All instrument functions specified on this list shall be provided. Additional instruments may be required to complete the instrument loops because of certain characteristics of the particular equipment provided. Such additional instruments shall be provided at no additional cost even though not specified in the Instrument Schedule or on the Contract Drawings.

2.2 TUBING AND TUBING FITTINGS

A. Instrument tubing between the process connection and instruments shall be ½ inch x 0.035 inch seamless annealed ASTM A269 type 316 stainless steel.

B. Tubing fittings shall be type 316 stainless steel and shall be the double-ferrule swage type. Flare, ball sleeve compression or single-ferrule swage type are not acceptable. Fittings shall be Crawford "Swagelok", Hoke "Gyrolok", or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
General requirements for the installation of primary elements specified in this section are listed on INSTRUSPEC sheets in paragraph 3.3 of this section and shown on the contract drawings.

B. Process Connections:
Unless otherwise specified, process taps shall comply with API RP550. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

C. Tubing:
Tubing shall be installed on supports spaced not more than 3 feet apart and shall run parallel of perpendicular to walls structural members, or intersections of vertical planes and the ceiling. Unless otherwise shown, tubing shall follow building surfaces closely or shall be carried in trays or conduit. Tubing shall not be supported from piping or equipment except at process taps or connections to the device served. Tubes supported directly on concrete surfaces shall be spaced at least _-inch from the concrete. Tubing support shall be one-hole malleable iron clamps with clamp backs as required. Bends shall be formed to uniform radii without flattening. Ends of tubing shall be square-cut and deburred before installation in fittings. Fittings shall be used for splices, connections, and turns near final connections. Bulkhead fittings shall be used when tubing enters a panel.

D. Signal Transmission:
1. Signal transmission between electric or electronic instruments not located within a common panel shall be 4 to 20 milliamperes and shall operate at 24 volts DC unless otherwise specified. Milliampere signals shall be current regulated and shall not be affected by changes in load resistance within the unit's rating.

Milliampere signals from field shall be converted to a 1 to 5 volt signal by dropping across a 0.1%, 250 ohm, 1/2 watt resistor at the external terminals of each panel, All instruments within the panel shall be parallel wired. Measurement loops shall be grounded at external terminals by bonding to the instrument panel signal ground bus. Isolating amplifiers for field equipment possessing a grounded input or output shall be provided.

2. High frequency (greater than 1 kHz) pulse rate signals from field transmitters shall be converted to DC voltage signals at the panel.
3. Platinum resistance temperature detector (RTD) outputs shall be carried to the control panel and converted to a dc voltage signal unless otherwise specified or shown.
4. All other transmission systems, such as impulse duration, low frequency pulse rate, and voltage regulated, will not be permitted except where specifically noted in the instrument schedule, paragraph 3.03 of this section. When transmitters with non-standard outputs are specified, their output shall be converted to 4 to 20 milliamperes at the field instrument.
5. Two wire equipment located in hazardous areas shall be made safe for the specified conditions by use of equipment and barriers approved by Underwriters Laboratories, Inc. (UL), Canadian Standards Association (CSA), or Factory Mutual (FM).

3.2 TESTS AND INSPECTIONS

A. General Requirements:

Materials, equipment, and construction included under this specification shall be inspected in accordance with the procedures set forth in the General and Special Conditions sections of the Contract Documents, Section 17000, and this section. Testing shall be performed in accordance with Section 17000, this section, and subsequent sections of this division.

B. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of section 17000.
2. Test Equipment: Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three times greater than the component under test. Each test instrument shall be calibrated prior to the commencement of a testing activity and at the completion of a testing activity. Certified calibration reports traceable to the National Bureau of Standards shall be included with the test report. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.
3. Testing Stages:
   a. General: Each instrument loop shall be tested in the following sequence:

Testing sequence	Form reference
Wiring	Section 17000-A
Individual components	Section 17000-B thru I
Individual loops	Section 17000-J
Loop commissioning	Section 17000-K

Testing of piping and wiring and individual components shall be completed with certified test reports provided to the Engineer prior to commencement of individual loop testing, which shall be completed with certified test reports provided to the Engineer prior to commencement of loop commissioning.

b. Individual Component Calibration and Test: Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test report form. Alarm trips, control trips, and switches shall be set to initial values specified in paragraph 3.03 of this section at this time. Final elements shall be checked for range, dead band, and speed of response.

   Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

c. Loop Test: Each instrument loop shall be tested as an integrated system. This test shall check operation from transmitter to readout components. Signals shall be injected at the signal connection to primary measuring elements.

   If any output device fails to indicate properly, corrections to the loop circuitry shall be made as necessary and the test repeated until all instruments operate properly

d. Closed Loop Commissioning Test: Commissioning test shall demonstrate stable operation of the loop under actual plant operating conditions. This test shall include adjustment of loop tuning parameters.

   Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4 amplitude damping

unless otherwise specified. A chart recording showing loop response to a step disturbance shall be provided for each loop. Two charts shall be made for cascade loops, one showing the secondary loop response with its set point on manual, and the second showing overall loop response. Each control loop with "batch" feature shall be adjusted to provide optimum response following start-up from an integral action saturation condition. Chart recording shall be provided showing this response. Chart recordings shall be made at sufficient speed and amplitude to clearly show 1/4 amplitude damping and shall be annotated to show loop number and title, and settings of parameters and set point.

3.3 SUPPLEMENTS

A. The supplements listed below, following the “End of Section” designation, are part of this Specification section.

B. Instrumentation Data Sheets.

END OF SECTION

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Analyzer - pH		SHEET 1 OF 1	
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.13	ADDENDUM/C.O.
TAG NO.		**AE / AIT - 0135**	**AE / AIT - 0908**		
Ref. Dwg. No.:	1	I-3	I-8		
PROCESS					
Location:	2	Vortex Seperator	Filters Building		
Service:	3	Sampling Point 1	Sampling Point 2		
Vessel / Line No.:	4				
Fluid:	5	Combined Sewer Overflow	Combined Sewer Overflow		
Temp. Min/Max:	6	5/170 °F	5/170 °F		
Press. Min/Max:	7	Max. 246 psi	Max. 246 psi		
PERFORMANCE					
Range:	8	1 - 12 pH units.	1 - 12 pH units.		
Accuracy:	9	±0.01% of full scale.	±0.01% of full scale.		
Temperature:	10	Min. 5 °F	Min. 5 °F		
Relative Humidity:	11	0-95% pH non-condensing.	0-95% pH non-condensing.		
Repeatability:	12	±0.01% of Span.	±0.01% of Span.		
Stability:	13	0.05% of Span for 24 hours, non-cumulative.	0.05% of Span for 24 hours, non-cumulative.		
Resolution:	14	0.004% mA(12-bit) analog output.	0.004% mA(12-bit) analog output.		
Response Time:	15	95% of Range in 5 seconds.	95% of Range in 5 seconds.		
SENSOR					
Type:	16	Submersible pH Sensor.	Submersible pH Sensor.		
Element:	17	pH and Ag/AgCl Reference Electrodes.	pH and Ag/AgCl Reference Electrodes.		
Enclosure/Housing:	18	Process Glass suitable for application with PTFE diaphragm.	Process Glass suitable for application with PTFE diaphragm.		
Mounting:	19	Immersion Type	Immersion Type		
Connections:	20	Process Conn.: Pg 13.5	Process Conn.: Pg 13.5		
Commun. Cable:	21	PVC jacketed submersible cable to transmitter; Length as required, 25 feet minimum.	PVC jacketed submersible cable to transmitter; Length as required, 25 feet minimum.		
Additional Features:	22	Supports Memosens Protocol.	Supports Memosens Protocol.		
TRANSMITTER					
Type:	23	Microprocessor-based, dual sensor Analyzer/Transmitter.	Microprocessor-based, dual sensor Analyzer/Transmitter.		
Output:	24	4-20 mA DC	4-20 mA DC		
Power Supply:	25	120 VAC ±10, 50/60 Hz, 10 watts.	120 VAC ±10, 50/60 Hz, 10 watts.		
Relays:	26	As Required	As Required		
Rating:	27	5 A at 120 VAC.	5 A at 120 VAC.		
Indication / Display:	28	Local LCD; 1/2 inch character height min.; Built-In Self-Diagnostics and Simulator (See Notes, Lines 36 & 37).	Local LCD; 1/2 inch character height min.; Built-In Self-Diagnostics and Simulator (See Notes, Lines 36 & 37).		
Enclosure/Housing:	29	NEMA 4X; Polycarbonate face panel; Plastic and Stainless steel housing.	NEMA 4X; Polycarbonate face panel; Plastic and Stainless steel housing.		
Mounting:	30	Wall Mount; Nylon mounting brackets.	Wall Mount; Nylon mounting brackets.		
Area Classification:	31	Not Applicable	Not Applicable		
Additional Features:	32	Keypad (See Notes, Line 38).	Keypad (See Notes, Line 38).		
NOTES					
Function:	33	Continuous monitoring system shall consist of pH sensor and a microprocessor based analyzer/transmitter designed to measure sample pH and produce a proportional output signal linear to the pH.			
Materials:	34	All wetted parts shall be chemical resistant liquid crystal polymer or other material compatible with the process fluid. Refer to Materials Compatibility Chart.			
Installation:	35	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Simulator:	36	Provide simulator used in conjunction with front panel controls and display to verify calibration, proper internal functioning of the analog-to-digital conversion, processing, outputs and setting up alarms.			
Self-Diagnostics:	37	Error messages shall indicate operational/equipment malfunctions, including EPROM failure (data is not valid), scaling card not present/not recognized, analog-to-digital converter not responding, RAM failure, and internal serial communication failure. All configuration data shall be stored in non-volatile EEPROM.			
Keypad:	38	Provide front panel, membrane sealed keypad for display control and transmitter function control testing and calibration. Front panel switch shall also allow alternate display of readouts for pH, temperature, and mA outputs.			
	39	pH probe can be connected to the Chlorine Analyzer transmitter if recommend by manufacturer			
MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	40	Hach			

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Analyzer - Total Residual Chlorine		SHEET 1 OF 1
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.16 / ADDENDUM/C.O.
TAG NO.		**AE / AIT - 0137**	**AE / AIT - 0910**	
Ref. Dwg. No.:	1	I-003	I-008	
PROCESS				
Location:	2	Vortex Separator	Fiters Building	
Service:	3	Sample Point 1	Sample Point 2	
Vessel / Line No.:	4			
Fluid:	5	Combined Sewer Overflow	Combined Sewer Overflow	
Temp. Min/Max:	6			
Press. Min/Max:	7			
PERFORMANCE				
Range:	8	0-10 mg/L	0-10 mg/L	
Accuracy:	9	±5% or ±0.03 mg/L	±5% or ±0.03 mg/L	
Temperature:	10	41 to 113 degrees F	41 to 113 degrees F	
Sensitivity:	11	N/A	N/A	
Repeatability:	12	0.01 ppm or 3.0% whichever is greater	0.01 ppm or 3.0% whichever is greater	
Stability:	13	N/A	N/A	
Response Time:	14	100 seconds or less for 90% change at a stable temperature and pH	100 seconds or less for 90% change at a stable temperature and pH	
SENSOR				
Type:	15	Colorimetric Chlorine Analyzer	Colorimetric Chlorine Analyzer	
Element:	16	Stainless Steel	Stainless Steel	
Capillary Tubing:	17	Material compatible with process fluid	Material compatible with process fluid	
Mounting:	18	Wall Mounted	Wall Mounted	
Connections:	19	Sample line: 1/4 inch OD Drain line: 1/2 inch ID	Sample line: 1/4 inch OD Drain line: 1/2 inch ID	
Area Classification:	20	NEMA 4X	NEMA 4X	
Additional Features:	21	Reagents	Reagents	
TRANSMITTER				
Type:	22	Analyzer/Transmitter.	Analyzer/Transmitter.	
Output:	23	Two 4-20 mADC isolated.	Two 4-20 mADC isolated.	
Power Supply:	24	120 VAC	120 VAC	
Relays:	25	N/A	N/A	
Setpoints:	26	N/A	N/A	
Indication / Display:	27	Large LED Display	Large LED Display	
Enclosure/Housing:	28	NEMA 4X	NEMA 4X	
Mounting:	29	Wall Mounted	Wall Mounted	
Area Classification:	30	Not Applicable.	Not Applicable.	
Additional Features:	31	Keypad (See Notes, Line 39).	Keypad (See Notes, Line 39).	
NOTES				
Function:	32	Unit shall analyze and indicate total chlorine residual in a sample piped to the unit.		
Materials:	33	All wetted parts shall be compatible with the process fluid.		
Installation:	34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Reagents:	35	Provide sufficient quantities of calibration reagents, and expendables for operation during construction and six months after substantial completion		
Menu Options:	36	Menu options shall include: mg/L total residual, call current in microamps, sample temperature in degrees F or C, Feed rate in mL/hr, high and low alarm setpoints, backflush cycles per day, output signal in mADC, access code status.		
Keypad:	37	Keypad shall be panel mounted and used for configuration, calibration, and diagnostics. All user settings shall be retained in memory. Configuration values shall be password protected.		
	38	Provide all accessories required, including Cleaning Kit, verification Kit, as well as all replacement parts as recommended by the manufacturer for operation during construction and six months after substantial completion.		
	39	Provide front panel, membrane sealed keypad for display control and transmitter function control testing and calibration. Front panel switch shall also allow alternate display of readouts for pH, temperature, and mA outputs.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	41	Hach		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Indicator - Rotameter		SHEET 1 OF 5
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.27 / ADDENDUM/C.O.
TAG NO.		FI - 3422	FI - 3423	FI - 3424
Ref. Dwg. No.:	1	I-4	I-4	I-4
PROCESS				
Location:	2	Sedimentation Basin 1	Sedimentation Basin 1	Sedimentation Basin 1
Service:	3	Fluidizing Water	Fluidizing Water	Fluidizing Water
Vessel / Line No.:	4	1.25"	1.25"	1.25"
Fluid:	5	Non-Potable Plant Water (W3)	Non-Potable Plant Water (W3)	Non-Potable Plant Water (W3)
Temp. Min/Max:	6			
Press. Min/Max:	7			
Flow Min/Max:	8	0-60 GPM	0-60 GPM	0-60 GPM
PERFORMANCE				
Range:	9	0-60 GPM	0-60 GPM	0-60 GPM
Accuracy:	10	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.
Operating Temp.:	11	200 degrees F maximum.	200 degrees F maximum.	200 degrees F maximum.
Operating Press.:	12	200 PSIG maximum.	200 PSIG maximum.	200 PSIG maximum.
ROTAMETER				
Type:	13	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).
Tube/Body:	14	316 S.S.	316 S.S.	316 S.S.
Metering Cone:	15	PTFE	PTFE	PTFE
Magnet:	16	PTFE-coated	PTFE-coated	PTFE-coated
Retainers:	17	Not Applicable	Not Applicable	Not Applicable
Seals:	18	Buna	Buna	Buna
End Fittings:	19	Not Applicable	Not Applicable	Not Applicable
Indication / Display:	20	Scaled Indication - Gauge Type	Scaled Indication - Gauge Type	Scaled Indication - Gauge Type
Enclosure/Housing:	21	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.
Mounting:	22	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.
Area Classification:	23	Not Applicable	Not Applicable	Not Applicable
Additional Features:	24	316 S.S. Fine Control Check and Needle Valves.	316 S.S. Fine Control Check and Needle Valves.	316 S.S. Fine Control Check and Needle Valves.
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Dwyer Instruments	Brooks Instruments	ABB

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Indicator - Rotameter		SHEET 3 OF 5
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.27 / ADDENDUM/C.O.
TAG NO.		**FI - 3425**	**FI - 3432**	**FI - 3433**
Ref. Dwg. No.:	1	I-4	I-5	I-5
PROCESS				
Location:	2	Sedimentation Basin 1	Sedimentation Basin 2	Sedimentation Basin 2
Service:	3	Fluidizing Water	Fluidizing Water	Fluidizing Water
Vessel / Line No.:	4	1.25"	1.25"	1.25"
Fluid:	5	Non-Potable Plant Water (W3)	Non-Potable Plant Water (W3)	Non-Potable Plant Water (W3)
Temp. Min/Max:	6			
Press. Min/Max:	7			
Flow Min/Max:	8	0-60 GPM	0-60 GPM	0-60 GPM
PERFORMANCE				
Range:	9	0-60 GPM	0-60 GPM	0-60 GPM
Accuracy:	10	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.
Operating Temp.:	11	200 degrees F maximum.	200 degrees F maximum.	200 degrees F maximum.
Operating Press.:	12	200 PSIG maximum.	200 PSIG maximum.	200 PSIG maximum.
ROTAMETER				
Type:	13	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).
Tube/Body:	14	316 S.S.	316 S.S.	316 S.S.
Metering Cone:	15	PTFE	PTFE	PTFE
Magnet:	16	PTFE-coated	PTFE-coated	PTFE-coated
Retainers:	17	Not Applicable	Not Applicable	Not Applicable
Seals:	18	Buna	Buna	Buna
End Fittings:	19	Not Applicable	Not Applicable	Not Applicable
Indication / Display:	20	Scaled Indication - Gauge Type	Scaled Indication - Gauge Type	Scaled Indication - Gauge Type
Enclosure/Housing:	21	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.
Mounting:	22	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.
Area Classification:	23	Not Applicable	Not Applicable	Not Applicable
Additional Features:	24	316 S.S. Fine Control Check and Needle Valves.	316 S.S. Fine Control Check and Needle Valves.	316 S.S. Fine Control Check and Needle Valves.
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Dwyer Instruments	Brooks Instruments	ABB

PRODUCT		Flow Indicator - Rotameter		SHEET 4 OF 5
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.27 / ADDENDUM/C.O.
TAG NO.		**FI - 3434**	**FI - 3435**	
Ref. Dwg. No.:	1	I-5	I-5	
PROCESS				
Location:	2	Sedimentation Basin 2	Sedimentation Basin 2	
Service:	3	Fluidizing Water	Fluidizing Water	
Vessel / Line No.:	4	1.25"	1.25"	
Fluid:	5	Non-Potable Plant Water (W3)	Non-Potable Plant Water (W3)	
Temp. Min/Max:	6			
Press. Min/Max:	7			
Flow Min/Max:	8	0-60 GPM	0-60 GPM	
PERFORMANCE				
Range:	9	0-60 GPM	0-60 GPM	
Accuracy:	10	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	
Operating Temp.:	11	200 degrees F maximum.	200 degrees F maximum.	
Operating Press.:	12	200 PSIG maximum.	200 PSIG maximum.	
ROTAMETER				
Type:	13	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	
Tube/Body:	14	316 S.S.	316 S.S.	
Metering Cone:	15	PTFE	PTFE	
Magnet:	16	PTFE-coated	PTFE-coated	
Retainers:	17	Not Applicable	Not Applicable	
Seals:	18	Buna	Buna	
End Fittings:	19	Not Applicable	Not Applicable	
Indication / Display:	20	Scaled Indication - Gauge Type	Scaled Indication - Gauge Type	
Enclosure/Housing:	21	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.	
Mounting:	22	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.	
Area Classification:	23	Not Applicable	Not Applicable	
Additional Features:	24	316 S.S. Fine Control Check and Needle Valves.	316 S.S. Fine Control Check and Needle Valves.	
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Dwyer Instruments	Brooks Instruments	ABB

PRODUCT		Flow Indicator - Rotameter		SHEET 2 OF 5
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.27 / ADDENDUM/C.O.
TAG NO.		**FI - 0732**	**FI - 0733**	**FI - 0734**
Ref. Dwg. No.:	1	I-11	I-11	I-11
PROCESS				
Location:	2	Rotameter Panel	Rotameter Panel	Rotameter Panel
Service:	3	Chlorine Solution Delivery	Chlorine Solution Delivery	Chlorine Solution to Vortex Influent
Vessel / Line No.:	4	2"	2"	2"
Fluid:	5	Chlorine Solution	Chlorine Solution	Chlorine Solution
Temp. Min/Max:	6			
Press. Min/Max:	7			
Flow Min/Max:	8	0-13 GPM	0-13 GPM	0-26 GPM
PERFORMANCE				
Range:	9	0-13 GPM	0-13 GPM	0-26 GPM
Accuracy:	10	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.
Operating Temp.:	11	200 degrees F maximum.	200 degrees F maximum.	200 degrees F maximum.
Operating Press.:	12	200 PSIG maximum.	200 PSIG maximum.	200 PSIG maximum.
ROTAMETER				
Type:	13	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).	High Flow Variable-Area Flow Meter; (See Notes, Line 25).
Tube:	14	Polyamid 12, Polysulphone, PVDF and PVC-U transparent	Polyamid 12, Polysulphone, PVDF and PVC-U transparent	Polyamid 12, Polysulphone, PVDF and PVC-U transparent
Float:	15	Teflon (PTFE)	Teflon (PTFE)	Teflon (PTFE)
O-Ring:	16	EPDM	EPDM	EPDM
Retainers:	17	PVC	PVC	PVC
Plugs/Adapters:	18	PVC	PVC	PVC
End Fittings:	19	PVDF	PVDF	PVDF
Indication / Display:	20	GPM	GPM	GPM
Enclosure/Housing:	21	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.	NEMA 4X; Stainless Steel Frame.
Mounting:	22	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.	Pipeline Mount in Horizontal Position.
Area Classification:	23	Not Applicable	Not Applicable	Not Applicable
Additional Features:	24			
NOTES				
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.		
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.		
Instrument Installation	29	Rotameter already installed shall be replaced with same (GF SK 21), if different instrument is selected required modifications to the piping shall be made by the contractor.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	38	Georg Fischer SK 21	Brooks Instruments (Note 29)	

PRODUCT		**Flow Indicator - Rotameter**		SHEET 5	OF 5
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.27	ADDENDUM/C.O.
TAG NO.		**FI - 0735**			
Ref. Dwg. No.:	1	I-11			
PROCESS					
Location:	2	Rotameter Panel			
Service:	3	Chlorine Solution Delivery			
Vessel / Line No.:	4	2"			
Fluid:	5	Chlorine Solution			
Temp. Min/Max:	6				
Press. Min/Max:	7				
Flow Min/Max:	8	0-13 GPM			
PERFORMANCE					
Range:	9	0-13 GPM			
Accuracy:	10	±2% of Maximum Flow; ±10% of Full Scale for extra low capacity meters.			
Operating Temp.:	11	200 degrees F maximum.			
Operating Press.:	12	200 PSIG maximum.			
ROTAMETER					
Type:	13	High Flow Variable-Area Flow Meter; (See Notes, Line 25).			
Tube:	14	Polyamid 12, Polysulphone, PVDF and PVC-U transparent			
Float:	15	Teflon (PTFE)			
O-Ring:	16	EPDM			
Retainers:	17	PVC			
Plugs/Adapters:	18	PVC			
End Fittings:	19	PVDF			
Indication / Display:	20	GPM			
Enclosure/Housing:	21	NEMA 4X; Stainless Steel Frame.			
Mounting:	22	Pipeline Mount in Horizontal Position.			
Area Classification:	23	Not Applicable			
Additional Features:	24				
NOTES					
General:	25	A Low Flow Rotameter constitutes flow conditions BELOW (and including) 40 GPH or 115 SCFH. A High Flow Rotameter constitutes flow conditions ABOVE 40 GPH or 115 SCFH.			
Materials:	26	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.			
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Tube Material:	28	A Borosilicate Glass Tube shall be used for most applications. A glass tube is not suited for applications with: water over 90°C (194°F), high pH (softens glass), wet steam (softens glass), caustic soda (dissolves glass), and hydrofluoric acid (etches glass). For these applications a stainless steel tube shall be used with a float that is magnetically coupled with an indicating gauge.			
Instrument Installation	29	Rotameter already installed shall be replaced with same (GF SK 21), if different instrument is selected required modifications to the piping shall be made by the contractor.			
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MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	38	Georg Fischer SK 21	Brooks Instruments (Note 29)		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Meter - Magnetic Flow Tube		SHEET 1 OF 2
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.29 / ADDENDUM/C.O.
TAG NO.		**96_FE/FIT-3461**	**96_FE/FIT-3462**	**96_FE/FIT-3471**
Ref. Dwg. No.:	1	I-4	I-4	I-5
PROCESS				
Location:	2	Sedimentation Basin #1	Sedimentation Basin #1	Sedimentation Basin #2
Service:	3	Sludge Pump 3424, 3425	Sludge Pump 3422, 3423	Sludge Pump 3434, 3435
Vessel / Line No.:	4			
Fluid:	5	Sludge	Sludge	Sludge
Temp. Min/Max:	6	32/60 degrees F.	32/60 degrees F.	32/60 degrees F.
Flow Min/Max:	7	0 / 150 GPM	0 / 150 GPM	0 / 150 GPM
PERFORMANCE				
Range:	8	0 -150 GPM	0 -150 GPM	0 -150 GPM
Accuracy:	9	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.
Temperature:	10	0 to 140 degrees F.	0 to 140 degrees F.	0 to 140 degrees F.
Repeatability:	11	±0.2% of range.	±0.2% of range.	±0.2% of range.
Fluid Conductivity:	12	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.
Impedance:	13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.
Drift:	14	Complete zero stability.	Complete zero stability.	Complete zero stability.
FLOW TUBE				
Type:	15	Lined Metal Flow Tube.	Lined Metal Flow Tube.	Lined Metal Flow Tube.
Element:	16	Flanged	Flanged	Flanged
Electrode/Liner:	17	Refer to Materials Compatibility Chart.	Refer to Materials Compatibility Chart.	Refer to Materials Compatibility Chart.
Line Size:	18	4"	4"	4"
Enclosure/Housing:	19	Die-cast, Low-copper Aluminum Alloy; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Epoxy paint finish.
Mounting:	19	316 S.S. Flange End Connections.	316 S.S. Flange End Connections.	316 S.S. Flange End Connections.
ANSI Class:	20	150 #	150 #	150 #
Additional Features:	21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.
TRANSMITTER				
Type:	22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.
Output:	23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.
Power Supply:	24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.
Indication / Display:	25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).
Enclosure/Housing:	26	NEMA 4X; Die-cast, Low-copper Aluminum Alloy	NEMA 4X; Die-cast, Low-copper Aluminum Alloy	NEMA 4X; Die-cast, Low-copper Aluminum Alloy
Mounting:	27	Remote, Wall	Remote, Wall	Remote, Wall
Connections:	28	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.
Commun. Cable:	29	Not Applicable	Not Applicable	Not Applicable
Area Classification:	30	Not Applicable	Not Applicable	Not Applicable
Additional Features:	31	Automatic zeroing.	Automatic zeroing.	Automatic zeroing.
NOTES				
Function:	32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.		
Accuracy:	35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.		
Span Adjustment:	36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-31 ft/sec.		
Signal Conditioning:	37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.		
Low Flow Cutoff:	38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.		
Totalizer:	39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.		
Spool Piece:	40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.		
	41			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	42	Rosemount	Krohne America, Inc.	ABB

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Flow Meter - Magnetic Flow Tube		SHEET 2 OF 2
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.29 / ADDENDUM/C.O.
TAG NO.		**96_FE/FIT-3472**	**83_FE/FIT-3710**	
Ref. Dwg. No.:	1	I-5	I-19	
PROCESS				
Location:	2	Sedimentation Basin #2	Dewatering Building	
Service:	3	Sludge Pump 3432, 3433	Sludge Feed to BFP	
Vessel / Line No.:	4			
Fluid:	5	Sludge	Thickened Sludge	
Temp. Min/Max:	6	32/60 degrees F.	32/60 degrees F.	
Flow Min/Max:	7	0 / 150 GPM	0 / 300 GPM	
PERFORMANCE				
Range:	8	0 -150 GPM	0 - 300 GPM	
Accuracy:	9	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	±0.5% of flow rate over 1-31 fps range; ±0.005 fps for flows below 1 fps.	
Temperature:	10	0 to 140 degrees F.	0 to 140 degrees F.	
Repeatability:	11	±0.2% of range.	±0.2% of range.	
Fluid Conductivity:	12	Minimum Limit: 5 µS/cm.	Minimum Limit: 5 µS/cm.	
Impedance:	13	Minimum Pre-amp Input: 1012 ohms.	Minimum Pre-amp Input: 1012 ohms.	
Drift:	14	Complete zero stability.	Complete zero stability.	
FLOW TUBE				
Type:	15	Lined Metal Flow Tube.	Lined Metal Flow Tube.	
Element:	16	Flanged	Flanged	
Electrode/Liner:	17	Refer to Materials Compatibility Chart.	Refer to Materials Compatibility Chart.	
Line Size:	18	4"	4"	
Enclosure/Housing:	19	Die-cast, Low-copper Aluminum Alloy; Epoxy paint finish.	Die-cast, Low-copper Aluminum Alloy; Submersible in 30 feet water for 48 hours; Epoxy paint finish.	
Mounting:	19	316 S.S. Flange End Connections.	316 S.S. Flange End Connections.	
ANSI Class:	20	150 #	150 #	
Additional Features:	21	316 S.S. Grounding Rings/Straps.	316 S.S. Grounding Rings/Straps.	
TRANSMITTER				
Type:	22	Pulsed DC Magnetic Flow Transmitter.	Pulsed DC Magnetic Flow Transmitter.	
Output:	23	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	4-20 mADC direct-acting, galvanically isolated; into 0-1000 ohms.	
Power Supply:	24	120 VAC ±10%, 60 Hz ±3 Hz.	120 VAC ±10%, 60 Hz ±3 Hz.	
Indication / Display:	25	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	Local LCD; Display Flow in Engineering Units; Provide Totalizer (See Notes, Line 39).	
Enclosure/Housing:	26	NEMA 4X; Die-cast, Low-copper Aluminum Alloy	NEMA 4X; Die-cast, Low-copper Aluminum Alloy	
Mounting:	27	Remote, Wall	Integral	
Connections:	28	Electrical Conn.: 3/4 inch NPT.	Electrical Conn.: 3/4 inch NPT.	
Commun. Cable:	29	Not Applicable	Not Applicable	
Area Classification:	30	Not Applicable	Not Applicable	
Additional Features:	31	Automatic zeroing.	Automatic zeroing.	
NOTES				
Function:	32	System shall monitor liquid flows, display monitored flow value, and output a signal proportional to monitored flow.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	34	Provide ISO Factory Calibration Certificate. Provide one calibrator suitable to calibrate all flow tubes provided.		
Accuracy:	35	Accuracy shall be: - Unaffected by changes in fluid velocity, density, pressure, temp. or conductivity (above min. conductivity limits). - Verified by flow test curves. Submit flow test curves for furnished meters with a minimum of 10 equally spaced flow points, using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. A test setup shall be submitted and approved prior to testing.		
Span Adjustment:	36	Unit shall have pre-calibrated continuous span adjustment over entire range. Provide direct reading thumbwheel switch or potentiometer for 1-31 ft/sec.		
Signal Conditioning:	37	Adjustable signal conditioning damping circuit with response times of 1-25 seconds minimum.		
Low Flow Cutoff:	38	Automatic low flow cutoff circuitry shall stop pulse output and local totalization when flow drops below 0.5% ±0.2% of calibrated upper range value.		
Totalizer:	39	Totalizer shall be: - 7-digit electromechanical or 8-digit electronic LCD unit, with reset and lithium battery backup. - Driven by high accuracy, field adjustable scaled pulse output (0.1-10 Hz or greater). - Integral with transmitter and visible through viewing window, or externally mounted adjacent to transmitter in a separate NEMA 4X enclosure or condulet with viewing window.		
Spool Piece:	40	Provide a replacement spool piece for each size flow tube where no bypass piping is provided.		
	41			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	42	Rosemount	Krohne America, Inc.	ABB

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Level Transmitter - Ultrasonic Type		SHEET 1 OF 1
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.54 / ADDENDUM/C.O.
TAG NO.		**96_LE/LIT-3401**	**96_LE/LIT-3411**	**81_LE/LIT-3502**
Ref. Dwg. No.:	1	I-4	I-5	I-17
PROCESS				
Location:	2	Sedimentation Basin #1	Sedimentation Basin #2	Sludge Holding Tank
Service:	3	Sedimentation Basin #1	Sedimentation Basin #2	Thickened Sludge Level
Vessel / Line No.:	4	Tank	Tank	Sludge Holding Tank
Fluid:	5	Combined Sewer Overflow	Combined Sewer Overflow	Sludge
Temp. Min/Max:	6	30/60 degrees F.	30/60 degrees F.	30/60 degrees F.
Level Min/Max:	7	0/15 Feet	0/15 Feet	0/15 Feet
PERFORMANCE				
Range:	8	0-15 Feet. Field verify Required	0-15 Feet. Field verify Required	0-15 Feet. Field verify Required
Accuracy:	9	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.	±0.25% of Max. Range with Temperature Compensation.
Temperature:	10	Electronics: -5 to 120 degrees F Transducer: -40 to 140 degrees F.	Electronics: -5 to 120 degrees F Transducer: -40 to 140 degrees F.	Electronics: -5 to 120 degrees F Transducer: -40 to 140 degrees F.
Resolution:	11	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.	±0.1% of Range or 2mm, greater of 2.
Damping:	12	Adjustable.	Adjustable.	Adjustable.
SENSOR				
Type:	13	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.	Ultrasonic, Non-Contacting Transducer.
Element:	14	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.	Piezoelectric Barium Titanite Crystal.
Blanking:	15	Adjustable Blanking Distance.	Adjustable Blanking Distance.	Adjustable Blanking Distance.
Beam Angle:	16	10 degree	10 degree	10 degree
Enclosure/Housing:	17	PVDF copolymer	PVDF copolymer	PVDF copolymer
Mounting:	18	Threaded Pipe Mount; Provide 316 S.S. Hardware	Threaded Pipe Mount; Provide 316 S.S. Hardware	Threaded Pipe Mount; Provide 316 S.S. Hardware
Commun. Cable:	19	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.	Communications Cable to transmitter, Length as required.
Area Classification:	20	Not Applicable	Not Applicable	Not Applicable
Additional Features:	21	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.	Built-In Temperature Compensation Sensor.
TRANSMITTER				
Type:	22	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.	Microprocessor Based Control Circuitry Transmitter.
Output:	23	Two 4-20 mADC isolated, into 0-750 ohms.	Two 4-20 mADC isolated, into 0-750 ohms.	Two 4-20 mADC isolated, into 0-750 ohms.
Power Supply:	24	120 VAC, 60 Hz.	120 VAC, 60 Hz.	120 VAC, 60 Hz.
Relays:	25	6 SPDT Level Alarm contacts with LED relay status indication.	6 SPDT Level Alarm contacts with LED relay status indication.	6 SPDT Level Alarm contacts with LED relay status indication.
Rating:	26	5A at 250 VAC.	5A at 250 VAC.	5A at 250 VAC.
Indication / Display:	27	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.	Multifield Back-lit LCD; Engineering Units; Loss of Echo Indication.
Software:	28	As Required by Manufacturer.	As Required by Manufacturer.	As Required by Manufacturer.
Enclosure/Housing:	29	NEMA 4X; Polycarbonate Enclosure.	NEMA 4X; Polycarbonate Enclosure.	NEMA 4X; Polycarbonate Enclosure.
Mounting:	30	Wall Mounted; 316 S.S. Hardware.	Wall Mounted; 316 S.S. Hardware.	Wall Mounted; 316 S.S. Hardware.
Area Classification:	31	Not Applicable	Not Applicable	Not Applicable
Additional Features:	32	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.	Electronic Filter to smooth signal variations.
NOTES				
Function:	33	Ultrasonic Level Transmitter shall be a continuous liquid level measuring system which produces an output signal linear with level.		
Installation:	34	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Calibration:	35	Provide ISO Factory Calibration Certificate.		
Beam Angle:	36	A 12 degree beam angle shall be used for ranges less than 33 feet, and a 5 degree beam angle shall be used for ranges greater than 33 feet.		
Keypad:	37	Provide keypad programmer for remote system programming and configuration. Programming and configuration values shall be stored in EEPROM memory that does not require battery back-up.		
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Milltronics - Division of Siemens	Endress + Hauser	Pulsar Inc.

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Level Switch - Ultrasonic Type**		SHEET 1	OF 1
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.62	ADDENDUM/C.O.
TAG NO.		**97_LSL-0904**			
Ref. Dwg. No.:	1	I-8			
PROCESS					
Location:	2	Sampling Point No.2			
Service:	3	Analytical Instruments			
Vessel / Line No.:	4				
Fluid:	5	Final Effluent			
Temp. Min/Max:	6	32/60 °F			
Press. Min/Max:	7	0/5 GPM			
Velocity Min/Max:	8				
Level Min/Max:	9	0.8 to 16.4 ft			
PERFORMANCE					
Range:	10	0.8 to 16.4 ft			
Repeatability:	11	±0.25% of Full Span.			
Resistance:	12	9.6K-ohms at 20 degrees C.			
Temperature:	13	-20 to 140 degrees F; Temp. Compensator: -40 to 160 degrees F.			
Beam Angle:	14	12 Degrees Conical.			
SENSOR					
Type:	15	Non-Contact Ultrasonic Transducer.			
Element:	16	Piezoelectric Electric Crystal.			
Blanking:	17	12 inches.			
Mounting:	18	Flange Mount; 316 S.S. Hardware.			
Additional Features:	19				
SWITCH					
Type:	20	Solid State Switch.			
Power Supply:	21	120 VAC ±15%, 60 Hz.; 15 watts maximum consumption.			
Relays:	22	2 independently adjustable alarm setpoint relays with SPDT contact outputs.			
Rating:	23	5A at 250 VAC.			
Switch Action:	24	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.			
Setpoints:	25	Low Setpoint (4" from Effluent Channel Bottom)			
Indication / Display:	26	Loss of Echo indication.			
Enclosure/Housing:	27	NEMA 4X.			
Mounting:	28	Switch mounted integrally to sensor.			
Area Classification:	29	Not Applicable			
Additional Features:	30	Built-In Digital Filter for EMI protection and external acoustical noise rejection.			
NOTES					
Transd. Function:	31	Transducer shall convert transmitter electrical pulses into sonic pulses directed toward the metered surface and then receive the reflected sonic pulses and convert them back into electrical pulses for reception by the transmitter.			
Switch Function:	32	Switch shall generate and time the electrical pulses, count and convert pulse travel times into values linearly proportional to level, and compare the level value to the setpoint.			
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
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MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	39	Milltronics - Division of Siemens	STI - Division of Magnetrol		

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT	Pressure Element - In-Line Type		SHEET 1 OF 1
PROJECT	EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.70 / ADDENDUM/C.O.

TAG NO.		**(See Notes, Line 31)**	**(See Notes, Line 32)**	**(See Notes, Line 33)**
Ref. Dwg. No.:	1			
PROCESS				
Location:	2			
Service:	3			
Vessel / Line No.:	4			
Fluid:	5			
Temp. Min/Max:	6			
Press. Min/Max:	7			
Velocity Min/Max:	8			
Up/Down Stream:	9			
SENSOR				
Type:	10	Elastomer Isolated Pressure Sensor, Ring Type.	Elastomer Isolated Pressure Sensor, Ring Type.	Elastomer Isolated Pressure Sensor, Ring Type.
Element:	11	Full 360 degree pressure sensor.	Full 360 degree pressure sensor.	Full 360 degree pressure sensor.
Size:	12	1-1/2"	2"	4"
Body Material:	13	PVC	PVC	PVC
Sleeve Material:	14	Teflon	Teflon	Teflon
Flange Material:	15	PVC	PVC	PVC
Connections:	16	Instrument Conn.: 1/2 inch NPT.	Instrument Conn.: 1/2 inch NPT.	Instrument Conn.: 1/2 inch NPT.
Mounting:	17	In-line Flange Mount	In-line Flange Mount	In-line Flange Mount
Area Classification:	18	Refer to Area Classification Chart.	Refer to Area Classification Chart.	Refer to Area Classification Chart.
Additional Features:	19			
G. / SW. / TRANS.				
Type:	20			
Tag No.	21	(See Notes, Line 31).	(See Notes, Line 32).	(See Notes, Line 33).
Ref. Data Sheet:	22	Refer to Pressure gauge Data Sheet for Tag No. requirements.	Refer to Pressure gauge Data Sheet for Tag No. requirements.	Refer to Pressure gauge Data Sheet for Tag No. requirements.
Mounting:	23	Integral Mount on Pressure Sensor via Instrument Connection port.	Integral Mount on Pressure Sensor via Instrument Connection port.	Integral Mount on Pressure Sensor via Instrument Connection port.
Area Classification:	24	Refer to Area Classification Chart.	Refer to Area Classification Chart.	Refer to Area Classification Chart.
Additional Features:	25			

NOTES		
Function:	26	Elastomer isolated pressure sensor shall be mounted in-line and provide full 360 degree pressure sensing.
Installation:	27	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.
Calibration:	28	Provide ISO Factory Calibration Certificate.
Orientation:	29	Location and orientation of the gauge/switch and pressure element assembly shall be coordinated with the piping and equipment installations so that gauge/indicator shall be easily read and accessed for maintenance by plant personnel.
Assembly:	30	The complete pressure assembly, including gauge or switch or transmitter, shall be factory assembled, filled and calibrated to the ranges or switch setpoints specified prior to shipment.
TAG NO.	31	83_PE-3709
TAG NO.	32	94_PE-0705, 94_PE-0711, 94_PE-0706, 94_PE-0712, 94_PE-0813, 94_PE-0814, 97_PE_0912, 97_PE_0914, 97_PE_0915, 95_PE_0133, 95_PE_0134, 95_PE_0135
TAG NO.	33	96_PE-3422, 96_PE-3423, 96_PE-3424, 96_PE-3425, 96_PE-3432, 96_PE-3433, 96_PE-3434, 96_PE-3435 CA_PE-1101, CA_PE-1201
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MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Red Valve Company	OPW Engineered Systems	

PRODUCT	Pressure Gauge - Bourdon Type	SHEET 1 OF 2	
PROJECT	EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS	SPEC. NO. 17211 - 3.3.73	ADDENDUM/C.O.

GAUGE		
Type:	1	Liquid Filled Gauge for pressure ranges >15 psi and vacuum ranges <30 inches-Hg.
Element:	2	316 S.S. Bourdon Tube and Socket; Heliarc Welded, unless otherwise specified.
Accuracy:	3	±0.5% of span.
Diaphragm Seal:	4	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.
Pressure Snubber:	5	Provide sintered stainless steel or brass (for copper pipe) pressure snubber threaded into gauge socket or in external steel housing with 1/2 inch NPT male and female connections.
Indication / Display:	6	Glass window; White and Black markings on Dial; 300 series S.S. movement; Built-In overload/underload stops; Rotary geared with Teflon S coating, or cam and roller type.
Enclosure/Housing:	7	4-1/2 inch Black Case; Solid front design constructed of glass filled polyester; Full blowout back for overpressure protection.
Mounting:	8	Stem Mounting; 1/2 inch male NPT connection on bottom.
Additional Features:	9	Threaded, glass filled polyester ring.
NOTES		
General:	10	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.
Installation:	11	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.
Calibration:	12	Adjustable pointer and externally accessible zero adjustment; Provide ISO Factory Calibration Certificate.
Process Isolation:	13	Provide all valves for process isolation in accordance with specifications in this Section.
Fill Fluid:	14	Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Fluorolube 63.
	15	
	16	
	17	

MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	18	Ashcroft	Helicoid	WIKA Instrument Corporation

INSTRUMENT

Requirements specified above shall apply to all instrument tag numbers listed below.

	Tag No.	Process Fluid	Diaphragm Seal Process Press. Min/Max (PSI)	Performance Range	Location / Service Reference Drawing No.
1	96_PI-3422	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3422 I-4
2	96_PI-3423	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3423 I-4
3	96_PI-3424	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3424 I-4
4	96_PI-3425	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3425 I-4
5	96_PI-3432	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3432 I-5
6	96_PI-3433	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3433 I-5
7	96_PI-3434	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3434 I-5
8	96_PI-3435	Sludge	Inline 0/100	0 to 100 PSI	Discharge Sludge Pump 3435 I-5
9	94_PI-0711	Sodium Hypochlorite	Inline -20/60	-20 to 60 PSI	Suction Dosing Pump 0711 I-11
10	94_PI-0705	Sodium Hypochlorite	Inline 0/160	0 to 160 PSI	Discharge Dosing Pump 0711 I-11
11	94_PI-0712	Sodium Hypochlorite	Inline -20/60	-20 to 60 PSI	Suction Dosing Pump 0712 I-11
12	94_PI-0706	Sodium Hypochlorite	Inline 0/160	0 to 160 PSI	Discharge Dosing Pump 0712 I-11
13	94_PI-0813	Sodium Bisulfite	Inline 30" Hg/15	30" Hg to15 PSI	Suction Dosing Pump 1101 I-12
14	94_PI-0814	Sodium Bisulfite	Inline 30" Hg/15	30" Hg to15 PSI	Suction Dosing Pump 1201 I-12
15	83_PI-3438	Plant Water	Inline 30" Hg/15	30" Hg to15 PSI	Plant Water I-18

PRODUCT	Pressure Gauge - Bourdon Type	SHEET 2	OF 2
PROJECT	EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS	SPEC. NO. 17211 - 3.3.73	ADDENDUM/C.O.

GAUGE		
Type:	1	Liquid Filled Gauge for pressure ranges >15 psi and vacuum ranges <30 inches-Hg.
Element:	2	316 S.S. Bourdon Tube and Socket; Heliarc Welded, unless otherwise specified.
Accuracy:	3	±0.5% of span.
Diaphragm Seal:	4	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.
Pressure Snubber:	5	Provide sintered stainless steel or brass (for copper pipe) pressure snubber threaded into gauge socket or in external steel housing with 1/4 inch NPT male and female connections.
Indication / Display:	6	Glass window; White and Black markings on Dial; 300 series S.S. movement; Built-In overload/underload stops; Rotary geared with Teflon S coating, or cam and roller type.
Enclosure/Housing:	7	4-1/2 inch Black Case; Solid front design constructed of glass filled polyester; Full blowout back for overpressure protection.
Mounting:	8	Stem Mounting; 1/4 inch male NPT connection on bottom.
Additional Features:	9	Threaded, glass filled polyester ring.
NOTES		
General:	10	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.
Installation:	11	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.
Calibration:	12	Adjustable pointer and externally accessible zero adjustment; Provide ISO Factory Calibration Certificate.
Process Isolation:	13	Provide all valves for process isolation in accordance with specifications in this Section.
Fill Fluid:	14	Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Fluorolube 63.
	15	
	16	
	17	

MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	18	Ashcroft	Helicoid	WIKA Instrument Corporation

INSTRUMENT

Requirements specified above shall apply to all instrument tag numbers listed below.

	Tag No.	Process Fluid	Diaphragm Seal Process Press. Min/Max	Performance Range	Location / Service Reference Drawing No.
1	83_PI-3709	Polymer Solution	Inline 0/100 PSI	0 to 100 PSI	Polymer System Discharge I-19
2	CA_PI-1101	Sodium Bisulfite	Inline -20/60 PSI	-20 to 60 PSI	Suction Transfer Pumps I-20
3	CA_PI-1201	Sodium Bisulfite	Inline -20/60 PSI	-20 to 60 PSI	Suction Transfer Pumps I-20
4	97_PI-0914	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump 0914 Discharge I-8
5	97_PI-0915	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump 0915 Discharge I-8
6	97_PI-0912	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump Discharge I-8
7	95_PI-0133	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump 0133 Discharge I-3
8	95_PI-0134	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump 0134 Discharge I-3
9	95_PI-0135	Final Effluent	Inline 0/30 PSI	0 to 30 PSI	Sample Pump Discharge I-3
10					
11					
12					
13					
14					
15					

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Pressure Switch		SHEET 1 OF 2
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.75 / ADDENDUM/C.O.
TAG NO.		**PSH - 0711**	**PSH - 0712**	**PSL-0912**
Ref. Dwg. No.:	1	I-11	I-11	I-8
PROCESS				
Location:	2	EAWQCF Sodium Hypochlo. System	EAWQCF Sodium Hypochlo. System	Sampling Point 2
Service:	3	Pump Discharge	Pump Discharge	Sample Pump Discharge
Vessel / Line No.:	4	2"	2"	2"
Fluid:	5	Sodium Hypochlorite	Sodium Hypochlorite	Final Effluent
Temp. Min/Max:	6	-40/100 °F	-40/100 °F	5/170 °F
Press. Min/Max:	7	0 - 160 PSI	0 - 160 PSI	0 - 7 PSI
Velocity Min/Max:	8			
PERFORMANCE				
Range:	9	0 - 160 PSI	0 - 160 PSI	0 - 30 PSI
Temperature:	10	-4 to 140 degrees F.	-4 to 140 degrees F.	-4 to 140 degrees F.
Repeatability:	11	±1% of range.	±1% of range.	±1% of range.
Deadband:	12	Adjustable	Adjustable	Adjustable
SENSOR				
Type:	13	Diaphragm/Piston Pressure Sensor.	Diaphragm/Piston Pressure Sensor.	Diaphragm/Piston Pressure Sensor.
Element:	14	Transducer.	Transducer.	Transducer.
Diaphragm Seal:	15	(See Notes, Line 35).	(See Notes, Line 35).	(See Notes, Line 35).
Capillary Tubing:	16	316 S.S. Capillary to extend from process connection to switch.	316 S.S. Capillary to extend from process connection to switch.	316 S.S. Capillary to extend from process connection to switch.
Mounting:	17	Integral Mount to Switch.	Integral Mount to Switch.	Integral Mount to Switch.
Area Classification:	18	Not Applicable	Not Applicable	Not Applicable
Additional Features:	19			
SWITCH				
Type:	20	Snap Action Switch.	Snap Action Switch.	Snap Action Switch.
Power Supply:	21	120 V	120 V	120 V
Relays:	22	SPDT, snap action.	SPDT, snap action.	SPDT, snap action.
Rating:	23	Not less than 10A at 120 VAC; 0.5A at 125 VDC.	Not less than 10A at 120 VAC; 0.5A at 125 VDC.	Not less than 10A at 120 VAC; 0.5A at 125 VDC.
Switch Action:	24	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.
Setpoints:	25	100 PSI ; Field adjustable.	100 PSI ; Field adjustable.	7 PSI ; Field adjustable.
Enclosure/Housing:	26	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.
Mounting:	27	(See Note 36)	(See Note 37)	(See Note 38)
Connections:	28	Process Conn.: 1/4 inch NPT;	Process Conn.: 1/4 inch NPT;	Process Conn.: 1/4 inch NPT;
Area Classification:	29	Not Applicable	Not Applicable	Not Applicable
Additional Features:	30	Set/Reset Point Adjustment (See Notes, Line 34).	Set/Reset Point Adjustment (See Notes, Line 34).	Set/Reset Point Adjustment (See Notes, Line 34).
NOTES				
General:	31	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Function:	32	Pressure Switch shall sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Set/Reset Point:	34	Provide Set and Reset Point adjustable external adjusting nuts and pressure setting scales in psi. Provide metal cover with gasket for adjusting nuts.		
Diaphragm Seal:	35	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.		
Mounting:	36	Diaphragm seal (94_PE-0711) shall be used for both Pressure Gauge (94_PI-0711) and Pressure Switch (94_PSH-0711) assembly as shown in mounting detail 2 on drawing I-20.		
Mounting:	37	Diaphragm seal (94_PE-0712) shall be used for both Pressure Gauge (94_PI-0712) and Pressure Switch (94_PSH-0712) assembly as shown in mounting detail 2 on drawing I-20.		
Mounting:	38	Diaphragm seal (97_PE-0912) shall be used for both Pressure Gauge (97_PI-0912) and Pressure Switch (97_PSH-0912) assembly as shown in mounting detail 2 on drawing I-20.		
	39			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Automatic Switch Company (ASCO)	Ashcroft	United Electric

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		Pressure Switch		SHEET 2 OF 2
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.75 / ADDENDUM/C.O.
TAG NO.		**PSL-0135**		
Ref. Dwg. No.:	1	I-3		
PROCESS				
Location:	2	Sampling Point 1		
Service:	3	Sample Pump Discharge		
Vessel / Line No.:	4	2"		
Fluid:	5	Final Effluent		
Temp. Min/Max:	6	5/170 °F		
Press. Min/Max:	7	0 - 7 PSI		
Velocity Min/Max:	8			
PERFORMANCE				
Range:	9	0 - 30 PSI		
Temperature:	10	-4 to 140 degrees F.		
Repeatability:	11	±1% of range.		
Deadband:	12	Adjustable		
SENSOR				
Type:	13	Diaphragm/Piston Pressure Sensor.		
Element:	14	Transducer.		
Diaphragm Seal:	15	(See Notes, Line 35).		
Capillary Tubing:	16	316 S.S. Capillary to extend from process connection to switch.		
Mounting:	17	Integral Mount to Switch.		
Area Classification:	18	Not Applicable		
Additional Features:	19			
SWITCH				
Type:	20	Snap Action Switch.		
Power Supply:	21	120 V		
Relays:	22	SPDT, snap action.		
Rating:	23	Not less than 10A at 120 VAC; 0.5A at 125 VDC.		
Switch Action:	24	Switch Opens/Closes at predefined setpoint(s); Normally Closed contact.		
Setpoints:	25	7 PSI ; Field adjustable.		
Enclosure/Housing:	26	NEMA 4X; Epoxy painted; Die-cast low copper aluminum alloy housing.		
Mounting:	27	(See Note 36)		
Connections:	28	Process Conn.: 1/4 inch NPT;		
Area Classification:	29	Not Applicable		
Additional Features:	30	Set/Reset Point Adjustment (See Notes, Line 34).		
NOTES				
General:	31	All wetted parts shall be compatible with the process fluid. Refer to Materials Compatibility Chart.		
Function:	32	Pressure Switch shall sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.		
Installation:	33	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.		
Set/Reset Point:	34	Provide Set and Reset Point adjustable external adjusting nuts and pressure setting scales in psi. Provide metal cover with gasket for adjusting nuts.		
Diaphragm Seal:	35	A diaphragm seal is required for all mediums except air or potable water. Diaphragm material shall be compatible with the process fluid. Refer to Diaphragm Seal Data Sheet for requirements.		
Mounting:	36	Diaphragm seal (95_PE-0135) shall be used for both Pressure Gauge (95_PI-0135) and Pressure Switch (95_PSL-0135) assembly as shown in mounting detail 2 on drawing I-20.		
	37			
	38			
	39			
MANUFACTURE		Provide products of one of the following, Or Equal:		
Manufacturer:	40	Automatic Switch Company (ASCO)	Ashcroft	United Electric

DATA SHEETS - PRIMARY SENSORS AND FIELD INSTRUMENTS

PRODUCT		**Thermometer**		SHEET 1	OF 1
PROJECT		EAST AREA WATER QUALITY CONTROL FACILITY IMPROVEMENTS		SPEC. NO. 17211 - 3.3.79	ADDENDUM/C.O.
TAG NO.		**TI - 0139**			
Ref. Dwg. No.:	1	I-003			
PROCESS					
Location:	2	Vortex Seperator			
Service:	3	Sampling Cabinet Temperature			
Vessel / Line No.:	4				
Fluid:	5	Air			
Temp. Min/Max:	6	0 to 150 Degree F			
Press. Min/Max:	7				
PERFORMANCE					
Range:	8	0 to 150 Degree F			
Accuracy:	9	±1% of Span.			
THERMOMETER					
Type:	10	4-wire RTD			
Element:	11	Pt100 RTD			
Thermowell:	12	Not Required			
Fill Fluid:	13	Not Required			
Indication / Display:	14	5 inch White Dial; Black Markings & Pointer; Adjustable dial position/angle.			
Enclosure/Housing:	15	304 S.S. Case; Hermetically Sealed.			
Mounting:	16	Local Mount.			
Connections:	17	Process Conn.: 1/2 inch NPT			
Area Classification:	18	Not Applicable			
Additional Features:	19				
NOTES					
Installation:	20	Refer to Contract Drawing Installation Details and manufacturer's recommendations for installation.			
Thermowell:	21	Thermowells provide isolation between temperature sensor and environment allowing removal/replacement of temperature sensor without compromising ambient region or process. Thermowell material shall be compatible with the process fluid.			
Fill Fluid:	22	Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.			
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
	31				
	32				
	33				
	34				
	35				
MANUFACTURE		Provide products of one of the following, Or Equal:			
Manufacturer:	36	Omega	Dwyer		

REFERENCES: Materials Compatibility and Area Classification Charts

MATERIALS COMPATIBILITY CHART

Process Fluid	Diaphragm	O-Ring	Gasket			
Wastewater / Sludge	316 SS	Buna-N	Buna-N			
Potassium	Carpenter 20	Viton	Viton			
Sodium Hypochlorite	Teflon	Teflon	Teflon			
Polymer	316 SS	Buna-N	Buna-N			
Phosphoric Acid	316 SS	Buna-N	Buna-N			
Alum	316 SS	Teflon	Teflon			
Chlorine Gas	Teflon	Teflon	Teflon			
Chlorine Solution	Teflon	Teflon	Teflon			
Sodium Chloride	Teflon	Teflon	Teflon			
Ammonia	316 SS	Teflon	Teflon			
Methanol	316 SS	Teflon	Teflon			
Carbon	316 SS	Buna-N	Buna-N			
Lime	316 SS	Teflon	Teflon			
Ferric Chloride	Teflon	Teflon	Teflon			
Caustic Soda	Teflon	Teflon	Teflon			
Sodium Bisulfite	Teflon	Teflon	Teflon			
Sodium Hydroxide	Teflon	Teflon	Teflon			
Scrubber Solution	Teflon	Teflon	Teflon			
Fluoride	Hastelloy C	Viton	Viton			
Phosphate	316 SS	Teflon	Teflon			

AREA CLASSIFICATION CHART

Location	Description
Class 1	Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.
Class 1, Division 1	A location (1) In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or (2) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.
Class 1, Division 2	A location (1) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the liquids vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (2) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation and might become hazardous through failure or abnormal operation of the ventilating equipment; or (3) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.
Class 2	Class II locations are those that are hazardous because of the presence of combustible dust.
Class 2, Division 1	A location (1) In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures; or (2) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes; or (3) In which Group E combustible dusts may be present in quantities sufficient to be hazardous.
Class 2, Division 2	A location (1) In which combustible dusts due to abnormal operations may be present in the air in quantities sufficient to produce explosive or ignitable mixtures; or (2) Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air; or (3) In which combustible dust accumulations on , in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitable by abnormal operation or failure of electrical equipment.
Class 3	Class III locations are those that are hazardous because of the presence of easily ignitable fibers or filings, but in which such fibers or filings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.
Class 3, Division 1	A location in which easily ignitable fibers or materials producing filings are handled, manufactured or used.
Class 3, Division 2	A location in which easily ignitable fibers are stored or handled (except in the process of manufacture).

* Source: NEC 2005 Edition - Article 500

SECTION 17260

PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and enclosures

B. Related Sections:
1. Section 01600, General Material & Equipment Requirements.
2. Section 03300, Cast-In-Place Concrete
3. Section 17000, Instrumentation, Control and Monitoring System General Requirements.
4. Section 17100, Loop Descriptions
5. Section 17275, Miscellaneous Panel Instruments.

1.2 QUALITY ASSURANCE

A. Standards, Codes and Regulations:
1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
   a. National Fire Protection Association 79, Annex “D” Standards, (NFPA).
   b. National Electrical Code, (NEC).
   c. National Electrical Manufacturer's Association Standards, (NEMA).
   d. American Society for Testing and Materials, (ASTM).
   e. Operational Safety and Health Administration Regulations, (OSHA).
   f. Underwriters’ Laboratory, Inc., (UL).
   g. State and Local code requirements.
   h. Where any conflict arises between codes or standards, the most stringent requirement shall apply.
2. All material and equipment shall be new and all panels shall be built in an Underwriters’ Laboratory, Inc (UL) approved panel shop and bear the UL label.

B. General Design Requirements:

1. Comply with the requirements of Section 17000, Instrumentation, Control and Monitoring System General Requirements.
2. Comply with the control descriptions of Section 17100, Loop Descriptions.

C. Factory Inspection:

Inspect each panel, console, device, and cabinet before testing and before shipping. Inspection shall include, but not be limited to the following:

1. Verify all "Approved as Corrected" comments on Shop Drawings were implemented.
2. Verify presence of and accuracy of nameplates and tags.
3. Verify that wire sizes and color-coding comply with the Contract Documents.
4. Verify presence of terminal blocks, terminal block numbers, and required quantity of spares.
5. Verify annunciator window engravings and quantity of spare windows comply with the Contract Documents.
6. Verify proper wiring practices and grounding.
7. Verify enclosure flatness, finish, and color.
8. Verify anchoring of wire bundles between subpanels and front panel-mounted devices.
9. Verify presence of applicable items specified in this Section.
10. Check and verify software licenses for latest release and license types.

D. Panel Operational Testing:

1. Test all input/output components to verify that internal panel wiring is properly terminated at correct locations. Verify initial ranges and settings.
2. Test all system hardware and software to verify proper operation as stand-alone units. Test shall include, but not be limited to, the following:
    a. Power distribution and breaker ratings to match approved Shop Drawings.
    b. Power fail/restart tests.
    c. Diagnostics checks.
    d. Demonstrate that all specified equipment functional capabilities are working properly.
3. Test components and devices requiring data transmission to verify that communication between such components is working properly. Verify communication by using the same media required for the completed system at the Site as indicated in the Contract Documents.
4. Perform integrated system test with all system equipment and simulated inputs/outputs connected to verify that equipment is performing properly as an integrated system.

5. Simulation devices shall be of suitable quality to not mask control panel defects.

1.3 SUBMITTALS

Comply with the requirements of Section 17000, Instrumentation, Control and Monitoring System General Requirements.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

Comply with the requirements of Section 17000, Instrumentation, Control and Monitoring System General Requirements.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.

B. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.

C. Components for installation on panel exterior shall be located generally as shown. Layouts shall be submitted for review in accordance with Section 17000, Instrumentation, Control and Monitoring System General Requirements.

D. Where permitted by location and layout as shown, panels and enclosures shall have full height rear access doors. Where rear doors are not possible, panels shall have full or half height front access doors.

E. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

F. Provide sub-panels for installation of all relays and other internally mounted components.

G. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.

H. Provide copper grounding studs for all panel equipment.

I. Provide the following convenience accessories inside of each control panel:
   1. One 120 VAC, 20A duplex, grounding type receptacle.
   2. One or more 120 VAC fluorescent light fixtures with 40 watt lamp and protective plastic shield to span across the width of the panel but not less than two-thirds the width of the panel, as a minimum.
   3. One 120 VAC, 20A, snap switch, to turn on the light, mounted in an outlet box with a cover and located so that it is easily accessible from access door.
   4. Service light with switch and duplex receptacle shall have its own circuit breaker and separate power feed.

J. The bottom 12-inches of free standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.

K. No device shall be mounted less than 36-inches above the operating floor level, unless otherwise specified.

L. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.

M. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6-inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.

2.2 IDENTIFICATION

A. Provide laminated plastic nameplates for identification of panels and components mounted thereon as follows:
   1. Nameplates shall be of 3/32-inch thick laminated phenolic type with white matte finish surface and black letter engraving.
   2. Panel identification nameplates to have 1/2-inch high letter engravings.
   3. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
   4. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.
   5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.

B. Tag all internally mounted instruments in accordance with the following requirements:
   1. Tag numbers shall be as listed in the Instrument Index.

2. The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
4. Identification tag shall be installed so that the numbers are easily visible to service personnel.
5. Front of panel mounted instruments shall have the tag attached to rear of device.

C. Tagging of the following items shall be accomplished with the use of adhesive plastic Brady USA, Inc. labels, or equal.
1. Tag all electrical devices (e.g., relays, timers, power supplies) mounted within control panels and enclosures.
2. Tag all pneumatic lines
3. Numerically tag all terminal blocks.
4. Color code and numerically tag wiring at each end.

2.3 PANELS AND ENCLOSURES

A. General:
1. Panels and enclosures shall meet the NEMA requirements for the type specified.
2. Sizes shown are estimates. CONTRACTOR shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required.

B. Construction Features:
1. Control panels located inside control or electrical room areas shall be NEMA 12 rated:
a. Fabricate enclosures using minimum 14-gage steel for wall or frame mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight

edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.

e. Use pan type construction for doors. Door widths shall not exceed 36-inches.

f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.

g. Provide oil resistant gasket completely around each door or opening.

h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.

i. Use stainless steel fasteners throughout.

j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with a white enamel finish.

k. Provide steel print pocket with white enamel finish.

l. Provide enclosure mounting supports as required for floor, frame, or wall mounting.

m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.

n. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.

o. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.

p. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.

q. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard and custom color charts furnished by the manufacturer. Provide one extra quart of touch-up paint for each exterior finish color.

r. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. or equal.

s. Provide one extra quart of touch-up paint for each exterior finish color.

2. Control panels located in field shall be NEMA 4X rated.
    a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
    b. Stainless steel screw clamp assemblies on three sides of each door.
    c. Rolled lip around three sides of door and along top of enclosure opening.
    d. Hasp and staple for padlocking.
    e. Provide a clear plastic, gasketed lockable hinged door to encompass all non-NEMA 4 front of panel instruments.
    f. Provide 3-inch high channel base assembly, with solid bottom, drilled to mate the panel to its floor pad.
    g. Floor Pad: Refer to Part 3 of this Section.
3. Field Panels (NEMA 7):
    a. General: Explosion-proof control enclosures shall be used to house monitoring and measuring devices in hazardous environments. Enclosures shall be suitable for use in NEC Class 1, Groups C and D or Class II, Groups E, F and G applications and comply with UL and CSA standards.
    b. Required Features:
        1) Light weight and corrosion resistant copper-free aluminum.
        2) Integral, cast-on mounting lugs.
        3) Left side door hinges.
        4) Viewing windows sized to suit internally mounted components.
        5) Stainless tell cover bolts.
        6) Cad-platted steel mounting pans.
    c. Manufacturers: Provide explosion-proof control enclosures of one of the following:
        1) Adalet.
        2) Or equal.
4. Where the application applies and with the approval of ENGINEER, wall mounted enclosures may be provided. The enclosure shall comply with Paragraph B.1., B.2. or B.3., except for the following:
    a. Locations shall be as shown on or as specified under other Sections.
    b. Panels may be all fiberglass, polycarbonate or ABS.
    c. Doors shall be full height.
    d. Corrosion resistant polyester quick release latches shall be provided.
    e. No extra holes or knockouts shall be provided. No light or convenience outlet need be provided.

C. Electrical Systems:

1. Control of Environment:

a. Outdoor Panels:

1) Provide adequately sized automatically controlled 120 VAC strip heaters to maintain temperature inside each enclosure above 40ºF to maximum of 80ºF when the outside temperature is -20ºF through 40º F.

2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU. Housing shall be constructed of corrosion resistant materials.

3) Provide thermostats to automatically control heating and cooling requirements without need of manual operation of a heating/cooling transfer switch.

4) Provide documentation if any of the above is deemed unnecessary.

b. Indoor Panels:

1) Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10ºF above ambient for condensation prevention inside panels.

2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU.

3) Provide documentation if any of the above is deemed unnecessary.

2. Power Source and Internal Power Distribution:

a. General: Control panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown.

b. Panels shall be provided with an internal 120 VAC power distribution panel with number of circuits and separate circuit breakers sized as required to distribute power to the panel components. Distribution panel shall contain two spare breakers, minimum.

3. Wiring:

a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 V at 90ºC for single conductors, color coded and labeled with wire identification.

b. For DC panel signal wiring, use No. 18 minimum AWG shielded.

c. For DC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 A, use sizes required by NEC standards.

d. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.

e. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.

f. Install wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.

g. Adequately support and restrain all wiring runs to prevent sagging or other movement.

h. Terminate internal panel wiring using tube insulated crimp-on connectors; soldered connectors are unacceptable. Use screw type terminal blocks 600-volt rated, mounted on DIN rails. Fused terminal blocks shall have LED blown fuse indication. Terminal blocks for 4-20 mA signals shall be fused and knife-disconnect terminal blocks. Terminal strips shall be identified as specified in this section. Identifiers shall be self-stick, plastic tape strips with permanent type, machine printed numbers. Hand-written labels are not acceptable. Provide Phoenix Contact, Entrelec or Allen Bradley.

i. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.

j. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.

k. For internal component-to-component wiring only, compression type terminal blocks are acceptable.

l. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).

m. Provide a separate terminal for grounding each shielded cable.

n. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.

o. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.

p. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.

q. Provide circuit breakers to protect each circuit, with no more than six instruments on a single circuit.

r. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.

4. Surge Protection:

a. General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in suitable metallic cases, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

b. Provide formal lightning and surge protection devices for all signal lines, data highways, and power interfaces with PLCs at remote sites. For signal lines, data highways, power feeds to control panels and PLC hardware, provide formal lightning and surge protection devices for all lines that originate or are routed outside a building on any part of the existing or proposed circuit, on in either buried or exposed raceways. Provide formal lightning and surge protection for all transmitters installed under this Contract in an outside environment.

c. Lightning and surge protection devices shall be standard manufactured products comprising multi-component networks or hybrid circuits. The units shall incorporate gas filled discharge tubes, and zener diodes providing full protection form line to line and from line to ground.

d. Units shall be pluggable, din-rail mounted, rated for a 10KA maximum surge current and voltage suitable for the type of circuit being protected. Reaction time shall be in the order of nanoseconds. Units shall include local and remote fail indication.

e. The units shall be as manufactured by Phoenix Contact, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment conformance with NEC

B. Unless otherwise noted, install indoor NEMA 4X panels on 4-inch concrete pad. Extend pad 4-inches beyond outside dimensions of base, all sides. Lay grout after panel sills have been securely fastened down.

C. Unless otherwise noted, install outdoor NEMA 4X panels on a reinforced concrete pedestal:
   1. Minimum Thickness: Eight-inches with No. 4 steel reinforcing bars at 12-inches on centers, each way.
   2. Minimum Size: Twelve-inches larger than outer dimensions of base, all sides.
   3. Provide excavation and backfill work in conformance with the specifications.
   4. Provide concrete work in conformance with Section 03300, Cast-In-Place Concrete.

D. Install anchor bolts and anchor in accordance with Section 01600, General Material & Equipment Requirements.

E. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 TESTING AND ADJUSTMENTS

A. Perform system testing and make any adjustments necessary in accordance with this Section and Section 17000, Instrumentation, Control and Monitoring System General Requirements.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

END OF SECTION

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SECTION 17275

MISCELLANEOUS PANEL INSTRUMENTS AND DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of miscellaneous panel- mounted instruments which form a part of the process control systems specified in Section 17200. Instruments specified in this section are required to provide an interface between the operator and the process. Application requirements are specified in the instrument schedule, paragraph 17200-3.03. 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. Related Work Specified Elsewhere:
1. Division 1 General Requirements
2. Section 17000 Instrumentation, Control and Monitoring System – General Requirements
3. Section 17211 Process Taps and Primary Elements.
4. Section 16165, Disconnect Switches
5. Section 16155, Low Voltage Combination Magnetic Motor Starters
6. Section 16175, Instrument Transformer, Meters, Switches, and Accessories

1.2 SUBMITTALS

Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. Drawings, information and technical data for all equipment as required in Section 17000 and this section shall be submitted. All required information for this section shall be included in one complete submittal.

1.3 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.

B. Manufacturer:

Equipment furnished under this section shall be the products of firms regularly engaged in the design and manufacture of such equipment for a minimum of five years.

C. Installer:
Installation, calibration and testing of equipment furnished under this section shall be performed by qualified, skilled technicians who are regularly engaged in such activities involving systems of similar complexity, and who possess all licenses and certificates required to perform such work.

PART 2 - PRODUCTS

2.1 POWER SUPPLIES

A. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.

B. The 24 VDC power supply shall meet the following requirements:
1. Input power: 115 vac, plus or minus 10 percent, 60 Hz.
2. Output voltage: 24 vdc.
3. Output voltage adjustment: 5 percent.
4. Line regulation: 0.05 percent for 10 V line change.
5. Load regulation: 0.15 percent no load to full load.
6. Ripple: 3 mV RMS.
7. Operating temperature: Full output current between -32 to 140 degrees Fahrenheit.
8. DIN rail mounting.
9. Integrated Selective Fused Breaking.
10. Local and remote fail indication.

C. Size the 24 vdc power supply to accommodate the design load plus a minimum 30 percent spare capacity. Provide calculation with the submittal.

D. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

E. Mount the 24 vdc power supply such that dissipated heat does not adversely affect other panel components.

F. Provide a Power Supply Diode Redundancy module from the same manufacturer of the power supplies.

G. Products and Manufacturers:
   1. Phoenix Contact.
   2. Puls.
   3. Allen Bradley.
   4. Or Equal.

2.2 INTRINSICALLY SAFE RELAY

A. General: Intrinsically Safe Relay shall electrically isolate circuits extending into Class I, Division I (Group A, B, C and D) hazardous areas from circuits in non-rated areas. Failures of the circuit within the hazardous area shall be indicated by illuminating a light emitting diode (LED) located on the face of the relay.

B. Required Features:
   1. Contact design: one Normally Open (NO) and one Normally Close (NC), isolated contacts.
   2. Contacts Rating: 8A at 110 VAC resistive, 5A at 30VDC resistive
   3. Contact Cycle Rating:
      a. Mechanical 10,000,000 operations.
      b. Electrical: 100,000 operations minimum at rated load.
   4. Electronic Module: Solid state components epoxy encapsulated in nylon shell.
   5. Supply Voltage: 115 VAC 50/60Hz.
   6. Supply Current: Relays energized, 1.7 VA.
   7. Sensitivity: 0-470,000 ohms Maximum specific resistance.
   8. Operation Temperature: -40°F to 150°F.
   9. Time delay: 0.5 seconds rising level, 3 seconds lowering level.

C. Products and Manufacturers: Provide one of the following:
   1. Phoenix Contact.
   2. Gems Sensors,
   3. Or equal.

2.3 INTRINSICALLY SAFE DC BARRIER

A. General: Intrinsically Safe DC Barrier shall electrically isolate DC circuits extending into Class I, Division I (Group A, B, C and D) hazardous areas from circuits in non-rated areas. Failures of the circuit within the hazardous area shall be indicated by illuminating a light emitting diode (LED) located on the face of the barrier.

B. Required Features:
   1. Current Input: 4 to 20 mA.
   2. Voltage Input: 0 to 10 VDC
   3. Input Resistance: 50 Kohms.

4. Electronic Module: Solid state components epoxy encapsulated in nylon shell.
5. Supply Voltage: 115 VAC 50/60Hz.
6. Operation Temperature: -40°F to 150°F.
7. DIN Rail Mount.

C. Products and Manufacturers: Provide one of the following:
1. Phoenix Contact.
2. Gems Sensors,
3. Or equal.

2.4 UNINTERRUPTIBLE POWER SYSTEM

A. General:
1. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.

B. Description: On line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.

C. Features:
1. Unit shall provide uninterrupted conditioned power, under fully loaded conditions, for minimum of 20 minutes. Unit shall be sized to accommodate power requirements for all equipment it is to power for the required length of time and shall provide ten percent spare output capacity at minimum.
2. Rating: 1.4KVA/1.0KW minimum.
3. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
4. Regulation: One to three percent load regulation with less than 2pF effective coupling capacitance for line to load.
5. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.
6. Output Frequency: 60 Hz ±0.5 Hz.
7. Operating Temperature: 1°C to 40°C.
8. Relative Humidity: Five to 90 percent non-condensing.
9. Normally Closed contact output for Battery Low and UPS fail alarms to be connected to a DCS discrete input.
10. Input Protection: Independent battery charger fuse and DC fuses.

11. Output Protection: Inherently current limited ferro-resonant transformer.
12. Battery Charger: Two-step charger, 8 A and 2 A.
13. AC Input: 120VAC, 60Hz, single phase, +15 percent, -20 percent.
14. AC Output: 120VAC, 60Hz, single phase, +3 percent, -3 percent.
15. Provide a DIN rail mount Bypass switch.

D. Products and Manufacturers:
1. Best Power Technology, Ferrups FE Series.
2. American Power Conversion Corp. (APC)
3. Or Equal.

2.5 CONTROL RELAY

A. Type: General purpose, plug-in Ice-cube type rated for continuous duty.

B. Construction Features
1. Coil Voltages: 24 VDC or 120VAC, as required.
2. Contacts: DPTD or 4PDT
   a. Silver cadmium oxide rated not less than 10 A resistive at 120 VAC or 24 VDC continuous.
   b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 5 A resistive at 120 VAC or 28 VDC continuous shall be provided
3. Relays to have clear plastic dust cover.
4. Relays to have pilot light to show energized coil.
5. Relays to have push-to-test and manual override.
6. Relays to be UL recognized.

C. Products and Manufacturers:
1. Allen Bradley
2. Square D Company.
3. Or equal.

2.6 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. The PLC system shall include as a minimum a power supply, network connections, I/O cards and CPU as shown and as required to achieve the specified functionality. The system shall be complete with all necessary processors, I/O modules, backplanes, power supplies, terminals, terminal bases, and cables. The plant control system hardware listed herein is provided for CONTRACTOR’s convenience and may not include all PLC hardware components that shall be provided.

B. The final system configuration shall utilize the System Manufacturer’s standard hardware and software to meet the functional requirements of these Specifications.

C. All equipment furnished under this Contract shall be provided to meet the functional requirements of these Specifications plus a 20 percent growth in project requirements, (e.g., graphic displays, alarms, additional instrumentation and equipment). All equipment shall be provided under this Contract, such that the entire 20 percent project growth can be implemented into the PLC, without any additional hardware cost to the OWNER.

D. The PLC shall have the ability to communicate with multiple remote I/O racks, or devices configured with multiple I/O modules. The PLC shall have the ability to support multiple data communications networks in the same chassis

E. Assembled System:
   1. Within the enclosure all I/O racks, processor racks, and power supplies shall be grounded and mounted to meet the manufacturer's specifications
   2. Provide a dry contact rated at 2 amperes and 120 volts a-c for remote indication of processor failure.
   3. PLCs shall be capable of being programmed and updated where installed.
   4. Provide interposing relays for all outputs to motor control centers, solenoids or contactor circuits
   5. Provide individual fuses for all analog and digital inputs and all analog outputs. Fuses shall be capable of being inspected without removal of and replaced without disassembly of the terminal block. Blown fuse LED status indicators shall be provided

F. The PLC shall perform the following functions:
   1. All I/O boards shall be capable of being removed without powering down any process controller resource
   2. Accept analog input signals (4 to 20 mADC) and dry contact input signals (120 VAC).
   3. All analog inputs shall have 16-bit resolution with 0.025 percent accuracy.
   4. Output analog signals (4 to 20 mADC) and contact output commands as required to meet interface requirements. Contact outputs shall be dry contacts rated for 120 VAC, 60 Hz, two amp service or 24 VDC
   5. Respond to interrogations for data and receive downloaded program changes and operating parameter changes from HMI’s or engineering workstation.
   6. Errors and/or failures shall be indicated locally by Light Emitting Diode (LED) and reported at the HMI. Multiple-bit errors shall cause immediate processor halt. Error diagnostic tables shall be user accessible and provide clear and accurate descriptions of PLC system and process level errors.

7. The unit shall be provided with the following timing elements:
    a. Real-time clock to provide time reference for processor and system operations
    b. Watchdog timer for monitoring system software operations to detect hardware malfunction or a non-productive loop (stall condition).
8. The processor should be able to perform basic arithmetic operations using floating-point data
9. The processor shall be programmed using ladder logic
10. The process controller, in conjunction with I/O modules, performs all system level operations, system and data table monitoring and maintenance, alarm detection, PID control, user program executions, network request and response handling.
11. The controller shall be able to operate within the following environmental parameters: Processor and I/O modules shall be capable of withstanding temperatures of 32°F to 122°F at a relative humidity of 5 to 95 percent (non-condensing) in system manufacturer's standard enclosures.
12. A single fault tolerant power supply shall be provided for each CPU, rack and I/O modules. Each power supply shall be capable of being powered from separate 120 Vac and 24 or 125 Vdc sources. The power supplies shall incorporate full power factor correction, AC input filtering, and a 40-millisecond hold up time.
13. Isolation transformers and other power normalization devices to protect against over voltage and frequency distortion characteristics shall be used where frequent power failures are common.

G. The PLC should have as a minimum the following features and capabilities:
    1. The CPU shall be a microprocessor with onboard dynamic random access memory (DRAM) and flash memory for read/write functions and storage of configured data without battery backup. The microprocessor shall operate:
        a. Minimum of 2.0 Mbytes of User memory
        b. The controller shall be able to operate within the following environmental parameters: Processor and I/O modules shall be capable of withstanding temperatures of 32°F to 120°F at a relative humidity of 5 to 95 percent (non-condensing) in system manufacturer's standard enclosures.
        c. Flash memory with minimum 64 Mbytes of memory.
        d. Product and Manufacturer:
            1) 1756-L71, by Allen Bradley
    2. Current Input Module:
        a. 4-20 mA DC
        b. Minimum of 6 isolated input channels.
        c. Product and Manufacturer

1) 1756-IF61, by Allen-Bradley

3. Current Output Module:
   a. 4-20mA DC
   b. Minimum of 8 output channels.
   c. Product and Manufacturer
      1) 1756-OF8, by Allen-Bradley
4. Discrete Digital Input Module:
   a. 120VAC voltage monitor
   b. Minimum of 16 individually isolated input channels.
   c. Product and Manufacturer.
      1) 1756-IA161, by Allen-Bradley
5. Discrete Digital Contact Output Module:
   a. Relay output (NO contacts, 120VAC 2A minimum).
   b. Minimum of 16 individually isolated output channels.
   c. Product and Manufacturer:
      1) 1756-OW161, by Allen-Bradley
6. Ethernet Interface Module:
   a. Standard Ethernet media (10base2, 10base5, 10baseT, 100baseT, fiber).
   b. RJ-45 interface.
   c. Standard TCP/IP communications.
   d. Subnet masking.
   e. Provide one module for communication with remote or extended racks.
   f. Provide one module for communication with the Foxboro DCS.
   g. Product and Manufacturer:
      1) 1756-EN2T, by Allen-Bradley
7. Ethernet TAP:
   a. Shall have two 10/100Mbps copper ports and one 100 Base-FX multi-mode fiber optic port, with LC connector.
   b. Support linear and device-level ring topologies for Ethernet/IP applications.
   c. Recovery rate for typical device-level ring less than 3ms.
   d. Voltage Rating: 24V DC
   e. Product and Manufacturer:
      1) 1783-ETAPxx, by Allen-Bradley.
8. I/O Chassis:
   a. Number of slots as needed.
   b. Product and Manufacturer:
      1) 1756-Ax, by Allen-Bradley.
9. Power Supply (PS):
   a. 120VAC input voltage.
   b. Minimum current output as required to power all local PLC modules.
   c. Product and Manufacturer:

1756-PA, by Allen-Bradley.

2.7 PLC PROGRAMMING SOFTWARE

A. Software shall support the development of the PLC ladder logic derived from process control strategies as specified herein. Software shall be IEC 1131-3 compliant Ladder Diagram as well as modular, function block type of control elements, which are familiar to control engineers, instrumentation technicians and electricians. The function blocks shall be computational blocks for performing arithmetic, operational blocks for performing such functions as move and convert values, file to file operations, communication blocks for communicating with other PLC's and system resources, special algorithm blocks for advanced control procedures such as shift register, and PID functions. The PID shall use traditional strategies such as proportional, integral derivative (PID) controllers, feed forward, cascaded controllers, etc. shall be provided. Tuning constants shall be easily set from operator consoles. For each analog loop, software to allow provision of status of the manual backup control to be monitored and an alarm generated when switch is not in automatic mode.

B. For each sequence or logic control loop, a disagreement alarm shall be triggered when a command (start-stop, etc.) is initiated and confirmation is not received.

C. Supplier shall provide and configure internal diagnostics alarms for the PLC hardware. Alarms shall be suitable to verify proper and to alert operators when alarm conditions occurs. This includes, but is not limited to annunciation blown fuse indication for all I/O, watchdogs for communications failure with any system processor or I/O address, and communications failure with existing third party equipment.

D. PLC software shall allow for editing of comments and other PLC documentation using traditional editors such as Notepad.

E. PLC software shall include as easy to use file and printing management module.

F. The PLC software shall include a report generation module for system information use. The reporting module should allow for user-configured reports.

G. The PLC software shall use intuitive, menu-driver environment and base package platform. These easy-to-use Graphical User Interface (GUI) packages shall perform configuration and maintenance operations.

H. The PLC software shall be compatible with Windows 8 professional, 64 bits or latest version.

I. The PLC software shall be fully compatible with all furnished PLC hardware.

J. Product and Manufacturer:
1. The City owns a complete licensed software package of RS Studio 5000 Full Edition Version 23.0, RSLinx Professional and RSNetWorx by Rockwell Automation. The supplier shall use its own software and license to configure, test and startup the system.
2. If other PLC, different than Controllogix Series as manufacture by Allen Bradley is provided, Supplier shall provide fully licensed programing software loaded in a configuration computer laptop. Laptop shall have the following minimum features:
   a. 15" Screen
   b. Intel core i5, 2.2 GHz processor,
   c. 6GB DDR3 in RAM memory,
   d. 750 MB hard drive
   e. Latest windows operating system
   f. Optical drive DVD reader.

2.8 FIBER OPTIC PATCH PANELS

A. Wall-mounted fiber optic patch panels shall accommodate a minimum of 12 individual fibers. Panels shall have a metal enclosure, hinged clear polycarbonate jumper door, jumper routing guides, strain relief points and lockable door. Appropriate quantities of connector modules shall be furnished. The total number of termination points shall not be less than 12.

B. Provide fiber optic cable patch panels as referenced on the Drawings and which meet the following requirements:
1. Furnished panels with the following accessories:
   a. Splice trays.
   b. Cable strain relief
   c. Bend radius protectors
   d. Routing guides
   e. Grommetted cable entries.
   f. Cable Connectors - Quick-connect, simplex and duplex-type LC couplers with self-centering, axial alignment mechanisms. Insertion loss not greater than 0.7 dB.
   g. Sufficient working space for removal of connectors
   h. Identification label.
   i. All cable management hardware required to accomplish the installation.
2. For splice patch panels mounted within control panels, accessories shall be arranged neatly within the panel.

3. Furnish cabinets with internal space to store, organize, and strain relieve incoming and outgoing cables.
4. Provide ground lug for cable support member and routing supports to maintain allowable cable bend radius.

C. Product and Manufacturers
1. Model #OR-615SMFC 12P, by Ortronics.
2. Or approved equal.

2.9 FIBER TERMINAL CONENCTORS

A. Furnish connectors and components and use specific tools and methods as recommended by the connector manufacturer to form complete and reliable fiber optic cable terminations.

B. Terminal connector shall be type LC, non-polishing, mechanical splice suitable for 50-micron multi-mode fiber optic cable or single-mode fiber optic cable. Terminal shall be constructed of a composite housing, ceramic ferrule and a fiber stub permanently bonded into the ferrule. The other end of the fiber stub shall be precisely cleaved and ready for splicing

C. The terminal connector performance characteristics shall be as follows:
1. Insertion Loss (Typical) - <0.30 dB.
2. Durability Delta (500 matings) - 0.2 dB.
3. Operating Temperature - -40 to +70 degrees C.
4. Tensile Strength - 22 lbs.

D. Terminal connectors shall be provided by one of the following manufacturers:
1. Corning Cable Systems.
2. Radiant Corporation.
3. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

Install each item in accordance with manufacturers recommendations and in accordance with the Contract Documents.

3.2 TESTING

Comply with the requirements of Section 1700, Process Control System Startup and Field Testing, and Section 1700, Instrumentation, Control And Monitoring System General Requirements.

END OF SECTION

SECTION 17500

DISTRIBUTED CONTROL SYSTEM (DCS)

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, material, and software required to furnish, install, test, calibrate, configure, place in operation, and document a complete Distributed Control System (DCS), as required on the Drawings and in this Section.

B. Provide DCS training of the City's personnel at the job site.

C. Provide a DCS maintenance contract.

D. Provide DCS guarantees and warranties.

E. Related Work Specified Elsewhere:
1. Division 1, General Requirements
2. Section 17000, Instrumentation, Control and Monitoring System – General Requirements
3. Section 17100, Loop Descriptions.

1.2 SUBMITTALS

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

A. Preliminary loop drawings in general accordance with the International Society of Automation (ISA) S5.4. At the DCS end show FBM connections and as a minimum the I/O block definition. Make provisions to show all components and associated connections required including the following information:
1. Tag numbers of each item.
2. Functional name of each item.
3. Manufacturer's model or catalog number for each item.
4. Location of each item.
5. Loop wiring drawings for panels and field components provided under Section Instrument Panels
6. Prior to the Operational Field Testing, provide updated loop drawings with all information as required above.
7. Field signal input/output (I/O) list with each point individually listed and cross-referenced to the loop drawings. It will include but not limited to alarm setpoints, range, engineering units and historical configuration.

8. DCS interconnection drawings showing all equipment, equipment locations, interconnecting cables and connectors with lengths indicated, and communication links.
9. Enclosure layout drawings including the following information:
    a. Front, side, and plan views.
    b. Dimensions.
    c. Nameplate legend including text, letter size, and colors to be used.
    d. Terminal block designations cross referenced to the I/O list.
10. Complete material and software list. Identify software components by title, functional description, revision identification and date, and other appropriate identifying information.
11. Provide the following product information for each component provided.
    a. Manufacturer's product name and number.
    b. Tag number (if applicable).
    c. Functional name.
    d. Description of construction and features.
    e. Performance data.
    f. Service requirements (power, environment, etc.).
    g. Dimensions.

B. Drawings shall be prepared using latest version of AutoCad and shall be provided on hardcopy and electronic media.

1.3 TESTING

A. Factory Testing: NOT USED

B. Operational Field Testing:

1. Check and approve the installation and connection of all DCS components prior to placing them into operation. Check and approve communication with the remote facilities.

2. Human Interface: Verify the operation of each human interface device including hardcopy generators, monitors, touch screens, function panels, keyboards, mice, and trackballs. Verify displays including environment configurations, passwords, security, etc. Verify operator navigation within the overall display structure. Verify each display for layout, symbols, colors, etc.

3. Data Acquisition: Test the system database. Verify analog inputs at five points rising and falling (4, 8, 12, 16, and 20 mA). Verify each alarm function. Verify scan rate, offset or gain, filtering, delta band, and engineering units. Toggle digital inputs to verify functions and scan rate.

4. Loop Functions: Verify the automatic and manual functions of each loop. Verify interfaces to other systems using communication emulators.

5. Data Management Testing: Verify Application Processor and Historian data collection, retrieval, display, and reporting periodically during the test using real time data collected.

6. Failure Mode Testing: Test all failure modes including loss of primary power source, loss of communications (Fieldbus, Nodebus, or LAN), loss of primary fault tolerant processors, loss of system communications (Fieldbus, Nodebus, or LAN), and loss of primary hardcopy devices.

7. For redundant communication links, verify that no single point of communications failure results in loss of function. Disconnect the primary communication cable (Fieldbus, Nodebus, or LAN), and verify that the automatic switchover to the redundant link is transparent to operation with no degradation of data transfer. Verify proper operation after reconnecting the cable.

8. Documentation: Provide evidence that each step has been satisfactorily performed. Include itemized check lists for each step and a witness signature area. Indicate any unresolved concerns. Provide all hardcopy information generated during the test.

9. Provide all test equipment necessary to perform the DCS testing.

C. Functional Field Testing and Startup:

1. Perform a complete system test to verify that all equipment and software is operating properly as a fully integrated on-line system. Verify that the intended monitoring and control functions are fully implemented and operational.

2. The system guarantee and warranty period shall begin upon successful completion of the Functional Field Test.

1.4 FINAL DOCUMENTATION

A. Provide the following Operation and Maintenance Manuals:
1. In printed form supplied in indexed, 3-ring binders (2 sets), and as electronic documentation on DVD or CD:
    a. Complete and detailed operating instructions for each hardware and software product.
    b. Complete and detailed maintenance instructions.
2. A list of all components to the module level.
3. All drawings.

B. Provide updated versions of all submittal information showing as-built conditions.

1.5 TRAINING

A. Provide operation and maintenance training for all hardware and software provided.

B. Site Training:
1. Maintenance training: Provide three (3) four hour training sessions for up to five City personnel for each session.
2. Operational training: Provide three (3) six hour training sessions for up to five City personnel for each session.

1.6 MAINTENANCE CONTRACT

At the end of the warranty period, the system will be added to the City's existing Alliance Maintenance agreement. An allowance for the full 12 month cost of this addition is included. Prior to final acceptance, the final cost will be prorated to coincide with the period of the existing agreement and paid as part of the final payment.

1.7 GUARANTEE AND WARRANTIES

A. Equipment, software, and materials that do not achieve design requirements after the installation shall be replaced to attain compliance at no addition cost to the City. Following replacement or modification, the Contractor shall re-test the component or loop and perform any additional procedures needed to place the complete system in satisfactory operation and attain approval from the Engineer.

B. The system shall be warranted for 12 months following acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

Provide all hardware and software necessary to meet the product and functional requirements of this Section and of the DCS requirements on the Drawings.

2.2 HARDWARE

A. CP-CF (CSO Chemical Building)
1. Upgrade Existing Processor.
2. Replace existing enclosure.
3. Upgrade existing Foxboro 100 Series FBMs to Series 200 FBM.
4. Add new Series 200 FBM modules to comply with the Input Output requirements of this contract.

B. CP-SP (CSO Sludge Pump Station Building)
   1. Upgrade existing Foxboro 100 Series FBMs to Series 200 FBM.
   2. Add new Series 200 FBM modules to comply with the Input Output requirements of this contract.

C. CP-FB (CSO Filter Building)
   1. Add new Series 200 FBM modules to comply with the Input Output requirements of this contract.

D. Provide a field device system FBM233 and install it in the existing CP located in the Intrenchment Creek Admin Building.
   1. This Ethernet interface shall interface the DCS with the Belt Filter Press PLC (AB Controllogix Series).
      a. DCS consume tags: 80
      b. DCS produce tags: 12
   2. Provide network equipment that include minimum two fiber optic port ST type.

E. Provide all cables, connectors, and wire taps necessary to meet the requirements of this Section.

2.3 SOFTWARE

A. General:
   1. Provide all software necessary for the required functions.
   2. All software shall be completely debugged and operable prior to shipment. The City shall not be required to provide any programming effort to achieve a fully operational system.
   3. System parameters (e.g., setpoints, alarm limits, and loop tuning constants) shall be entered or modified using a Workstation with a modular key board.

B. Operating Software
   1. The operating software shall match existing running software at the facility.

PART 3 - EXECUTION

3.1 GENERAL

A. In addition to other requirements herein, coordinate with others to effect the following at East Area Water Quality Control Facility (EA-WQCF).

   1. DCS termination: Identify spare Input Output points in the existing DCUs at the EA-WQCF and coordinate with contractor so it is clear where to terminate the field wiring related to the new instruments.

2. Preliminary Submittals: Prepare loop wiring drawings related to the DCS control panels based on the Input Output List provided as part of Specification Section 17100, Loop Descriptions.
3. DCS Field Wire Installation: Provide signal cabling and power connection instructions to Contractor.
4. DCS Field Wire Inspection: Verify proper signal cabling and fiber optic connection installation. Coordinate, and witness with the Contractor, the application of electrical power to all electric powered DCS components.
5. DCS Communication Link Connection: Make final wire and fiber optic connections to DCS components.
6. DCS Communication Link Inspection: Verify proper test procedures and results. Verify proper installation.
7. Coordinate with the Contractor for the following field testing.
   a. Operational
   b. Functional
8. Communication with Other Control Panels: The DCS shall monitor and control unit processes as specified in Section 17100, Loop Description. Provide the necessary documentation for coordination purposes and software configuration.

B. DCS Communication Link Configuration:
1. Configure all communication links to vendor provided control panels installed at EA-WQCF under this contract. The DCS shall communicate with the Programmable Logic Controllers (PLC) over Ethernet using Ethernet IP protocol.

C. Final Documentation: Incorporate additional loop wiring drawing and I/O list information into the existing O&M manual.

3.2 SOFTWARE CONFIGURATION

A. Control Strategies are provided as functional requirements in specification Section 17100, Loop Descriptions. Provide all software, programming, and configuration necessary to effect the required functions.

B. EA-WQCF Sludge Pumps
1. Delete all software configuration related to the existing Sedimentation Basing Sludge Pumps and associate equipment as shown in the contract drawings. It should include, control logic, Human Machine Interface (HMI) screens, etc. Do not delete the historian data or the data blocks since the pumps could be used in the future in other application.
2. Configure the software to integrate the new sludge pumps into the existing DCS application according to the control strategies and matching the existing plant standards.

3. Update or configure new screens related for the sedimentation basing and sludge pumps.

C. EA-WQCF Sampling Stations
1. Configure the software to integrate the new influent and effluent analytical values into the existing DCS application according to the control strategies and matching the existing plant standards.
2. Update or configure new screens related to the sampling points.
3. Delete analytical points from the system that are no longer in used.

D. EA-WQCF Sludge Holding Tank
1. Configure the software to integrate the new sludge holding tank into the existing DCS application according to the control strategies and matching the existing plant standards.
2. Configure new control screens related for the sludge holding tank collector drive.

E. EA-WQCF Belt Filter Press System
1. Configure the software to integrate the new Belt Filter Presses and their ancillary systems into the existing DCS application according to the control strategies and matching the existing plant standards. The ancillary systems include:
   a. Sludge Feed Pumps.
   b. Sludge Feed Grinders
   c. Polymer System.
   d. Belt Conveyor.
2. Configure a new process screen for the Belt Filter Presses and their ancillary systems including the sludge holding tank.

F. Alarming shall match the requirements of the existing system.
Submit a list of alarm including tag, description, trigger setpoint, priority.

G. Historical Trending: Provide the following new trend screens
1. Trend 1: Influent sampling station
   a. Chlorine residual
   b. PH
   c. Station On/off
2. Trend 2: Effluent sampling station
   a. Chlorine residual
   b. PH
   c. Station On/off
3. Trend 3: Belt Filter Press
   a. Sludge Flow
   b. Polymer Flow
   c. BFP run status
4. Provide five more new historical trend screens with four pens each.

H. Historian Configuration

1. Existing tag related to the EA-WQCF solid processing pumps and analytical instruments shall be re-used.
2. Configure 200 new tags into the existing historian. List of tags will be define by the city and engineer during construction.

++ END OF SECTION ++

SECTION 17940
COMMUNICATION LINKS

PART 1 – GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all fiber optic and wire communication links to interconnect components of the Distributed Control System (DCS), security (access) system and fire alarm system as shown on the Drawings and as specified herein. See the DCS Block Diagram, drawings for additional communication link requirements, including equipment locations and quantities.

B. Items provided under this Section are installed in enclosures provided under Section 17110, Panels and in wireways provided under Division 16, Electrical or existing.

C. Related Work Specified Elsewhere:

1. Division 1, General Requirements
2. Section 16121, Instrumentation and Communication Cable.
3. Section 17000, Instrumentation, Control and Monitoring – General Requirements
4. Section 17260, Process Control Panels and Hardware

1.2 SUBMITTALS

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

A. Manufacturer installation recommendations for all products. Provide complete installation procedures that will be followed for this work.

B. Test procedures prior to testing. Provide test documentation after testing.

C. Training procedures prior to training.

D. Catalog cut sheets.

1.3 FINAL DOCUMENTATION

A. Provide final documentation required by Section 17000.

B. Provide all test documentation.

1.4 TRAINING

Provide one day of training for City personnel during installation. Provide one day of

training for City personnel during post-installation testing.

PART 2 - PRODUCTS

2.1 FIBER OPTIC COMMUNICATION LINKS

A. Fiber Optic Cable:

1. Each cable shall contain a minimum of 18 functional fibers after installation, connection, and testing are complete.

2. Fiber shall be a multimode, graded index, solid glass waveguide, and shall be coated to preserve the intrinsic strength of the glass. Each fiber shall be color coded. Fiber shall have the following characteristics:

Parameter	**Characteristic**
Core diameter:	62.5 microns
Cladding diameter	125 microns
Refractive index delta	2.0 percent
Numerical aperture (NA)	0.275
Attenuation at 1300 nm	1.0 dB/km maximum
Bandwidth at 1300 nm	500 MHz/km minimum
Attenuation at 850 nm	3.75 dB/km maximum
Bandwidth at 850 nm	160 MHz/km minimum

3. Cable shall include a buffer tube surrounding the fibers, one or more strength members, and an outer jacket. Cable components shall be of continuous material with no factory splices, holes, blisters, or other imperfections. Cable shall have the following characteristics:

Parameter	**Characteristic**
Material	non-metallic
Tensile load rating	600 lb minimum, long term
Bend radius rating	5 inches maximum unloaded (0-180 lb); 10 inches maximum loaded (181-600lb)

Diameter	0.5 inches nominal

4. Buffer tube shall allow for free fiber movement and thermal expansion. Buffer tube shall be flooded internally with a gel compound to prevent fiber contamination and freezing stress from moisture.

5. Strength members shall protect fibers from mechanical stress during installation and required service.

6. Cable shall be for outdoor installation in conduit.

7. Fiber optic cable shall be Corning Cable Systems, AT&T, or equal.

B. Fiber Optic Connectors:

1. Provide a connector on each end of each fiber.

2. Type: ST (bayonet twist-lock keyed).

3. Typical attenuation: 0.2 dB.

4. Maximum attenuation: 0.4 dB.

5. Loss repeat: less than 0.2 dB per 1,000 reconnects.

6. Fiber optic connector shall be Corning Cable Systems, AT&T, or equal.

C. Fiber Optic Patch Panels:

1. Provide a patch panel at fiber optic cable termination as shown on the Drawings.

2. Patch panel shall include coupling panel(s), bayonet/threaded couplings, and a lockable door. Patch panel shall totally enclose the connectors and patch cords. Provide 19-inch rack mounting brackets.

3. Mount 2 patch panels side-by-side in enclosures provided under Section 17200, Panels as required. Terminate each fiber optic cable at a separate patch panel.

4. Going clockwise around the site, terminate the incoming cable at the left patch panel and the outgoing cable at the right patch panel.

5. Fiber optic patch panel shall be Corning Cable Systems, AT&T, Black Box, or equal.

6. Coupling panel shall be Corning Cable Systems, AT&T, Black Box, or equal.

7. Couplings shall be Corning Cable Systems, AT&T, Black Box, or equal.

8. Mounting bracket shall be Corning Cable Systems, AT&T, Black Box, or equal.

D. Fiber Optic Patch Cords:

1. Provide patch cords to interconnect two cable fibers between panels (pass through jumper) or to connect cable fibers to converters as indicated on the Block Diagram. Each patch cord shall have 2 fibers for 2 direction communication.

2. Patch cord fibers shall be 62.5-micron with associated attenuation and bandwidth parameters as specified. Each fiber shall have an individual thermoplastic tight buffer tube, strength member, and a thermoplastic jacket.

3. Provide a minimum of 20 percent spare or 2 spare patch cords, whichever is greater, of each type and length.

4. Fiber optic patch cords shall be Corning Cable Systems, AT&T, or equal..

E. Fiber Optic Splice Enclosures:

1. Fibers shall not be spliced except where specifically approved in writing by the Engineer. The following shall not be acceptable reasons for splicing fibers: cable length availability or cost; cable installation convenience or cost.

2. If used, splice enclosures shall protect spliced fibers from moisture, soil, strain, or other damage. At each splicing location, sufficient cable length shall be provided to properly rack and splice the cables and to allow for additional future splices.

3. Ground splice enclosures to earth per Division 16, Electrical.

4. Fiber optic splice enclosure shall be Corning Cable Systems, AT&T, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General

1. Provide all equipment, instrumentation, and supplies necessary for installation.

2. Remove wire from existing wireways as required.

3. Install fiber optic communication links to ensure a minimum number of splices. Fiber splices shall be made only with written approval from the Engineer prior to implementation. Wire conductors shall not be spliced.

4. Provide a minimum of 5 feet spare cable (fiber optic and wire) coiled at each cable access point (manholes, handholes, and trenches).

5. Provide cable supports in manholes and handholes according to requirements in Division 16, Electrical. Existing cable supports may be used where available and not damaged.

6. Tag all cables, fibers, and conductors according to Division 16, Electrical, Section 16120, Conductors. Provide tag documentation.

7. Pull a 200-pound tensile strength polyolefin cord through each conduit where cable is pulled.

8. Install all cable according to manufacturer recommendations. Pull all cable through conduit at the same time. Do not exceed the manufacturer recommended pulling tension. See Division 16, Electrical, Section 16120, Conductors for additional requirements.

B. Fiber Optics:

1. Demonstrate to the Engineer that manufacturer installation recommendations are strictly followed for all fiber optic components.

2. Fiber optic cable fibers shall be "fanned out" and each individual fiber shall be sleeved over with a kevlar reinforced furcation tube. At the convergence point of all furcation tubes, provide fiber strain relief with a fan-out collar. Provide fiber strain relief at each connector. Provide cable gel blocking. Provide dust caps on each fiber connector until final assembly. Provide dust caps on each connector that is not coupled.

3. Attenuation for a single fiber optic connection point (connector through coupling through connector) shall be 0.7 dB maximum.

4. Where fiber optic splices are necessary and approved, fibers shall be fusion spliced. Attenuation for a single splice shall be 0.2 dB maximum. Test each

splice with an Optical Time Domain Reflectometer (OTDR) bi-directionally to verify compliance at the time of splicing. Splices not conforming to these specifications shall be redone to meet specifications. Provide cable moisture protection during splicing operations.

5. Attenuation for each fiber optic link shall be 13 dB maximum, as required for a minimum gain margin of 4 dB. The gain margin is the decibel difference between the gain of the fiber optic converters (17 dB per Section 17900) and the loss budget of the fiber optic link (fiber optic cables, connectors, patch cords, and splices).

3.2 TESTING

A. Provide all equipment, instrumentation, and supplies necessary for testing. The Engineer shall have the option to witness and actively participate in the on-site tests.

B. Fiber Optic Pre-installation Testing:

Prior to installing each cable, provide an Optical Time Domain Reflectometer (OTDR) test for each fiber at 1300 nm wavelength on the shipping spool. The OTDR test shall verify that each fiber meets the manufacturer attenuation specifications and that the cable was not damaged during shipping. Provide hard copy test documentation, including traces. Obtain approval from the Engineer prior to cable installation.

C. Fiber Optic Post-Installation Testing:

1. After cables and connectors are installed, OTDR test each fiber in both directions at 1300 nm wavelength. Provide hard copy and diskette test documentation.

2. After patch cords and couplings are installed, end-to-end attenuation test each fiber between transceiver connectors in both directions at 1300 nm wavelength. Use a stabilized light source and an optical power meter. Provide test documentation, including reference power reading.

3. Provide test documentation to the Section 13900, DCS supplier including detailed specifications for all cables and connectors used.

D. Fiber Optic Test Documentation:

Test documentation shall include cable and fiber identification; fiber length; test direction; test wavelength; traces; fiber attenuation; attenuation breakdown for each fiber segment, connector, and coupling; and splice attenuation if applicable.

E. Wire testing:

Test wire per Section 16999, Acceptance Testing and Calibration of Division 16, Electrical.

END OF SECTION