EXHIBIT C

TECHNICAL SPECIFICATIONS

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SECTION 01005
MISCELLANEOUS REQUIREMENTS

1.01 GENERAL

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

1.02 INTERFERENCE WITH EXISTING WORKS

A. The pump station and distribution piping shall remain in continuous service for the duration of the Work. 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 that 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.

1.03 MAINTAINING WATER, 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 is no interruption in the flow of aforementioned utilities, except as expressly scheduled in Section 01100, Special Project Procedures. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as bypass piping, 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 the night hours and weekends. Upon approval by the City, the Contractor may work on the existing utilities at such times if he so chooses at no additional cost to the City.

1.04 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.

1.05 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. Two copies shall also be furnished concurrently to the Electrical Contractor, to use in preparing his order for starting equipment. The Electrical Contractor shall also prepare a composite tabulation of all of these motors and electric heaters, as specified under ELECTRICAL WORK - GENERAL.

1.06 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.

+++ END OF SECTION 01005 +++

SECTION 01010
SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

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

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

The Work includes, but is not limited to demolition of existing ductile iron pipe, fittings, and valves; installation of new above and below grade ductile iron pipe, fittings, and valves; installation of new flow meters; construction of reinforced concrete foundation slabs; structural and architectural modifications to the existing pump station building to facilitate the new above grade piping; landscaping; temporary bypass piping; dewatering; electrical and controls; storm drainage; erosion and sediment control; and all incidentals and appurtenances required for construction of the Work described herein.

C. The work to be performed under this contract is located on Airport Loop Road at the Hartsfield-Jackson Atlanta International Airport Pump Station.

+++ END OF SECTION 01010 +++

SECTION 01011
UNIQUE REQUIREMENTS

PART 1 - GENERAL

1.01 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.

1.02 EXISTING FACILITY OPERATIONS

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

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 Engineer before any Work is undertaken on the connections or alterations.

1.03 SEQUENCING

A. General: The Contractor shall be solely responsible for all construction sequencing. The Contractor shall prepare and submit a construction sequencing plan to the City for review. The sequencing plan shall include, but is not necessarily limited to, distribution system bypass plans for each work area shown on the Drawings.

B. Notify the City at least 48 hours prior to relocating piping or diverting flows.

C. Sequence Submittal:

1. Submit a proposed sequence with appropriate times of starting and completion of tasks to Engineer for review.

2. The sequencing plan shall include, but is not limited to, distribution system bypass plans for each work area shown on the Drawings.

1.04 SITE SPECIFIC SPECIAL REQUIRMENTS

A. The Contractor shall maintain the existing flow rate and pressure in the distribution system piping associated with the Work at all times during construction. The Contractor shall furnish, install, and operate any required bypass piping, pumps, valves, etc. required to maintain continuous distribution system service.

B. Parking for Contractor personnel shall be fully contained within the site boundaries. No parking is permitted on any public roads or on any streets within the neighborhood. If necessary, the Contractor shall make arrangements for remote parking for its personnel, at a site approved by the Engineer, at no additional cost to the City.

C. All traffic must enter and exit the site through the pump station driveway.

D. Contractor is advised there are numerous pressurized pipes, energized conduits and duct banks, overhead and underground utilities 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.

E. 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, fertilized, and strawed.

F. The Contractor shall be responsible for maintaining and cleaning the pump station access driveway from the date it occupies the Construction Site through the final completion of the construction period.

G. The Contractor shall comply with all safety and security requirements associated with the performance of work on the Hartsfield-Jackson International Airport property.

+ + + END OF SECTION 01011 + + +

SECTION 01014
WORK SEQUENCE

PART 1 - GENERAL

1.01 SCOPE

A. Work under this Section includes construction sequencing and provision of temporary facilities necessary to maintain full operation of the Hartsfield-Jackson Atlanta International Airport Pump Station at all times during construction and to maintain the existing flow and pressure within the distribution piping associated with the Work

B. The existing pump station supplies water to the Hartfield-Jackson International Airport and service shall not be interrupted without written permission from the Owner. The Contractor shall coordinate the work to avoid any interference with normal operation of the pump station and water mains. The Contractor shall comply with the following general requirements:

1. Provide temporary pipes, valves, fittings, and other facilities necessary to meet the requirements of this Section.
2. Notify the Engineer at least 48 hours prior to starting any Work.

C. Penalties imposed on the City as a result of any loss of pump station service that are the result of 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 loss of service.

1.02 SUBMITTALS

A. The Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a pipeline, valve, electrical circuit, equipment or structure from service. The schedule shall be coordinated with the construction schedule and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe the Contractor's method for bypassing the pump station flows, the length of time required to complete said operation, the necessary materials and equipment which the Contractor shall provide in order to prevent loss of pump station and/or water main service.

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

1.03 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:

1. 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.
2. The written plan shall be supplemented by drawings, sketches, and details as required to show the logic of the plan and make it understandable.
3. 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.
4. 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

3.01 GENERAL

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

3.02 REQUIRED SEQUENCES

The following items define the order of certain construction steps which must occur in order to properly and safely operate and maintain the treatment facilities.

A. Contractor shall provide the City with the proposed sequence of construction for review and approval.
B. The Contactor shall provide the City with the proposed bypass plans for each work area shown on the Drawings as related to the proposed sequence of construction. All bypass plans and work area isolations shall include measures to maintain flow and pressure to each service area within the distribution system to match the required flow conditions as defined by the City. All bypass plans shall be presented to the City for review. No work shall proceed without authorization from the City.

C. The Contractor may elect to utilize and maintain operation of the existing below grade manifold and bypass piping during construction of the new above grade manifold and bypass piping.

3.03 MISCELLANEOUS CONSTRUCTION

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

3.04 OPERATION OF EXISTING FACILITIES

The Contractor shall coordinate with the City for operation of the existing piping and valves.

+++ END OF SECTION 01014 +++

SECTION 01016
OCCUPANCY

PART 1 – GENERAL

1.01 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 01016 +++

SECTION 01040
COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

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

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.

1.02 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.

1.03 EXISTING UTILITIES

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

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, Unique Requirements of these Specifications.

+ + + END OF SECTION 01040 + + +

SECTION 01045
CUTTING AND PATCHING

PART 1 GENERAL

1.01 DEFINITIONS

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

1. Cutting and patching is performed for coordination of the work, to uncover work for access or inspection, to obtain samples for testing, to permit alterations to be performed or for other similar purposes.
2. Cutting and patching performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to be "cutting and patching" under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be "cutting and patching".
3. "Demolition" and "Selective Demolition" are recognized as related- but-separate categories of work, which may or may not require cutting and patching as defined in this section; refer to "Demolition" sections of Division 2.

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

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

1.02 SECTION INCLUDES

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

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

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

1.03 RELATED SECTIONS

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

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

1.04 QUALITY ASSURANCE

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

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

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

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

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

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

a. Stonework and stone masonry.
b. Window wall systems.
c. Ornamental metal.
d. Firestopping
e. Stucco and ornamental plaster.
f. Carpeting.
g. Wall Coverings.

D. Before cutting and patching the following categories of work, obtain approval to proceed.

1. Structural steel.

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

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

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

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

1.05 SUBMITTALS

Procedural Proposal for Cutting and Patching: Where prior approval of cutting and patching is required, submit proposed procedures for this work well in advance of the time work will be performed and request approval to proceed. Include the following information, as applicable, in the submittal:

1. Describe nature of the work and how it is to be performed, indicating why cutting and patching cannot be avoided. Describe anticipated results of the work in terms of changes to existing work, including structural, operational and visual changes as well as other significant elements.
2. List products to be used and firms including their qualifications that will perform work.
3. Give dates when work is expected to be performed.
4. List utilities that will be disturbed or otherwise be affected by work, including those that will be relocated and those that will be out-of-service temporarily. Indicate how long utility service will be disrupted.
5. Approval by the Architect to proceed with cutting and patching does not waive the Architect's right to later require complete removal and replacement of unsatisfactory work.
6. When cutting and patching of structural work involves the addition of reinforcement, submit details and engineering calculations to show how that reinforcement is integrated with original structure to satisfy requirements.

1.06 WARRANTY

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

PART 2 PRODUCTS

2.01 MATERIALS

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

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

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

PART 3 EXECUTION

3.01 EXAMINATION

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

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

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

3.02 PREPARATION

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

B. Protection: Protect existing construction during cutting and patching to prevent

damage. Provide protection from adverse weather conditions for portions of the Project that might be exposed during cutting and patching operations.

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

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

3.03 PERFORMANCE

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

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

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

1. In general, where cutting is required, use hand or small tools designed for sawing or grinding, no hammering and chopping. Cut holes and slots neatly to size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. To avoid marring existing finish surfaces, cut the exposed or finished side into concealed surfaces.
3. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill.
4. Comply with requirements of applicable Sections or Division-2 where cutting and patching require excavating and backfilling.
5. By-pass utility services such as pipe or conduit, before cutting, where services are shown or required to be removed, relocated or abandoned. Cut-off pipe or conduit in walls or partitions to be removed. Cap valve or plug and seal the remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after by-passing and cutting.

D. Patching: Patch with durable seams that are as invisible 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.

3.04 CLEANING

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

B. Do not permit traffic over unprotected floor surface.

+ + + END OF SECTION 01045 + + +

SECTION 01060
REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

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

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

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

1.02 NPDES PERMITS FOR STORM WATER DISCHARGES

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

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

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

"Storm water discharge associated with industrial activity" means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. For the categories of industries identified in subparagraphs (i) through (x) of this subsection, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including

tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(ix) and (xi) omitted for brevity.

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

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

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

+++ END OF SECTION 01060 +++

SECTION 01100
SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 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.

1.02 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.

1.03 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.

1.04 HAZARDOUS LOCATIONS

The existing manholes and related areas are hazardous locations, in that explosive concentrations of sewage gas may be present. The Contractor is cautioned that the above areas 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.

1.05 CONNECTIONS TO WORK BY OTHERS

This project does not include Work to be connected to Work by others.

1.06 WATER FOR CONSTRUCTION PURPOSES

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + + END OF SECTION 01100 + + +

SECTION 01200
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 Part 1 - Item 1 - Base Bid

Payment for work under this item shall be based on the lump sum bid, and shall include all labor, supervision, materials, equipment, testing, temporary controls, incidentals and appurtenances, including all temporary facilities, required to construct the project as shown on the Drawings and as specified. Progress payments shall be made in accordance with the provisions of GC-41.

++ END OF SECTION 01200 ++

SECTION 01320
CONSTRUCTION PHOTOGRAPHY

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, equipment and materials required to provide the Owner with digital construction photography of the Project as specified herein.

B. The Contractor shall provide for professional videos and photographs to be made prior to and after construction to provide documentation of conditions and aid in any damage claims assessment. All conditions which might later be subject to disagreement shall be shown in sufficient detail to provide a basis for decisions.

C. Video and photo files shall become the property of the Owner and none of the video or photographs herein shall be published without express permission of the Owner.

1.02 PRE AND POST CONSTRUCTION PHOTOGRAPHY

A. Prior to the beginning of any work, the Contractor shall provide for professional videos and photographs of the work area to record existing conditions.

1. The Contractor shall furnish a complete videotaped record of the pipeline route. The video tape shall include the date of taping and shall contain audio commentary to emphasize existing conditions along the entire route.

2. The route shall be videotaped prior to beginning of construction. The Contractor shall furnish three sets of compact disks containing the videotaped data to the Engineer.

3. The route shall also be videotaped at the completion of construction when directed by the Engineer. The video tape shall show the same areas and features as in the preconstruction videos. The Contractor shall furnish three sets of compact discs containing the videotaped data to the Engineer.

B. The pre-construction videos shall be submitted to the Engineer within 15 calendar days after receipt of construction Notice to Proceed by the Contractor. Post construction videos and photographs shall be provided prior to final acceptance of the project.

1.03 PROGRESS PHOTOGRAPHS

A. Photographs shall be taken to record the general progress of the Project during each pay period. Photographs shall be representative of the primary work being performed at the time.

B. All photographs shall be taken with a digital camera. The photographs shall include the date and time marking in the digital record. All photographs shall be labeled on a tab connected to the bottom of the photo to indicate date and description of work shown.

PART 2 PRODUCTS

2.01 PHOTOGRAPHS

A. Photography and video files shall be provided in CD-ROM format.

B. Photographs shall also be provided in hard copy format. The photographs shall include the date and time marking on the photograph. All photographs shall be labeled on a tab connected to the bottom of the photograph. Tab label shall contain:

1. Project name.

2. Orientation of view.

3. Description of work shown.

C. All compact disks (CDs) furnished under this section shall be suitable for viewing with Windows Media Player.

PART 3 EXECUTION

3.01 SUBMITTALS

A. No construction shall start until pre-construction photography has been completed and accepted by the Engineer.

B. A minimum of ten 8 x10-inch progress photographs shall be submitted with each application for payment. The view selection will be as determined by the Engineer. Photographs shall be submitted in Print File Archival Preservers, 8 1/2 x 11-inch plastic sleeves pre-punched for a 3-ring binder.

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

D. The Contractor shall be responsible for all discrepancies not documented in the pre-construction videos and photography.

+ + + END OF SECTION 01320 + + +

SECTION 01350
PROJECT DOCUMENT TRACKING AND CONTROL SYSTEMS

PART 1 – GENERAL

1.01 SCOPE

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

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

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

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

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

B. The Contractor shall be required to utilize the web-based DTCS system to generate documents in the proper format for submission to the City. The Contractor shall access the system through the internet using a compatible web browser.

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 11 x 17 documents, double sided, on site for the entire duration of the Project. All documents must be scanned in and attached to the appropriate document, including submittals, shop drawings, O&M's and all other documents requested by the Engineer.

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

1. Company Directory: Addresses, Phone Numbers, Personnel Contacts, etc.

2. Drawings Log: Current Drawing revision log

3. Submittals (Integrated with Project Schedule through Activity codes)

4. Transmittals

5. Requests for Information and Answers (RFIs)

6. Change Documents, Including:

   a. Requests for Proposal (RFPs)

   b. Work Authorizations (WAs)

   c. Change Order Requests (CORs)

   d. Change Orders (CO)

   e. Design Clarifications (DC)

7. Field Decisions & Clarification Memos

8. Notice of Non-Compliance

9. Construction Issue Memos

10. Punchlists

11. Meeting Minutes & Agendas

12. Correspondence

13. Work Plans

15. Start-up Plans

16. Equipment Operation and Maintenance Training

F. The Contractor shall utilize the complete capabilities of the DTCS to meet the requirements of this Section. The Contractor shall provide a highly trained and experienced construction project controls person knowledgeable in construction work sequencing, productivity, scheduling and invoicing. 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 Provision and Training

1. The City of Atlanta shall provide to the contractor a license of or access to the DTCS software at no cost. The City of Atlanta will provide training in the use of the DTCS software to at least one Contractor's employee at no cost. It shall be the responsibility of the Contractor to ensure that staff attend City-provided training and are afterwards proficient in the use of the DTCS software.

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

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

J. Access through the internet to the DTCS shall be operational within 30 days following the pre-construction meeting date.

1.02 COMPANY DIRECTORY

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

1.03 DRAWING LOG

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

1.04 SUBMITTALS/SHOP DRAWINGS

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

B. Submittals & Product Data: A list of all required submittals will be entered into the DTCS by the Contractor. Submittals shall be incorporated into packages, with

the submittal numbering format to be provided by the COA's engineer. The Contractor will log and track all submittals utilizing the DTCS. Each review cycle shall be entered into the DTCS. The Contractor shall identify as activities in the CPM schedule, 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.

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

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

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

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

1.05 CORRESPONDENCE

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

1.06 TRANSMITTAL LOG

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

1.07 REQUEST FOR INFORMATION & ANSWERS

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

1.08 CHANGE DOCUMENTS

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

1.10 PUNCHLISTS

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

1.11 MEETING MINUTES AND AGENDA

The City shall monitor and manage the meeting minute process. The City will forward meeting minutes to the Contractor electronically. The City will log the meeting minute items into the DTCS within 3 days of the meeting date.

1.12 PROGRESS PAYMENTS /REQUISITIONS FOR PAYMENT

The Contractor is responsible for creating progress payment applications directly from the DTCS software and then forwarding them to the City electronically along with hard copies by 4:00 p.m. at the end of each update/billing period. 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. Failure of a Contractor to maintain project record documents, maintain current and properly prepared daily reports or to submit the project schedule will be just cause for withholding of the monthly or final payment.

+++ END OF SECTION 01350 +++
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SECTION 01400
QUALITY ASSURANCE/QUALITY CONTROL

PART 1 GENERAL

1.01 SCOPE

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

1.02 SITE INVESTIGATION AND CONTROL

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

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

1.03 INSPECTION OF THE WORK

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

B. The Work shall be conducted under the general observation of the Engineer and is subject to inspection by representatives of the City acting on behalf of the City to ensure strict compliance with the requirements of the Contract Documents. Such inspection may include mill, plant, shop, or field inspection, as required. The Engineer or any inspector(s) shall be permitted access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

C. The presence of the Engineer, or any inspector(s), however, shall not relieve the Contractor of the responsibility for the proper execution of the Work in accordance with all requirements of the Contract Documents. Compliance is the responsibility of the Contractor. No act or omission on the part of the Engineer, or any inspector(s) shall be construed as relieving Contractor of this responsibility. Inspection of Work later determined to be non-conforming shall not be cause or excuse for acceptance of the non-conforming Work. The City may accept non-conforming Work when adequate compensation is offered and it is in the City's best interest as determined by the City.

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

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

1.04 TIME OF INSPECTION AND TESTS

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

B. Whenever the Contractor is ready to backfill, bury, cast in concrete, hide, or otherwise cover any Work under this Contract, the Engineer shall be notified not less than three work days in advance to request inspection before beginning any such Work of covering. Failure of the Contractor to notify the Engineer at least three work days in advance of any such inspections shall be reasonable cause for the Engineer to order a sufficient delay in the Contractor's schedule to allow time for such inspection. The costs of any remedial or corrective work required, and all costs of such delays, including its impact on other portions of the Work, shall be borne by the Contractor.

1.05 SAMPLING AND TESTING

A. The Contractor shall retain and pay for an independent materials testing agency approved by the Engineer and the City of Atlanta as required by the General Conditions. This independent testing agency will develop and submit a testing plan for quality assurance on each type of work activity. The testing agency will document the processes and procedures utilized to verify and maintain quality work. When not otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the most current standards, as applicable to the class and nature of the article or materials considered. However, the Engineer reserves the right to use any generally accepted system of inspection which, in the opinion of the Engineer, will ensure the Engineer that the quality of the workmanship is in full accord with the Contract Documents.

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

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

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

1.06 CONTRACTOR'S QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

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

B. The Contractor shall furnish the Engineer a project specific QA/QC Plan. The Plan shall contain a comprehensive account of Contractor's QA/QC procedures as applicable to this job. The Contractor shall furnish for review by the Engineer, no later than 14 days after receipt of notice to proceed, the QA/QC plan proposed to be implemented. The plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction will be permitted to begin only after acceptance of the QA/QC Plan. The detailed requirements for this Plan are delineated in the following paragraphs. No

payments will be made to the Contractor until the QA/QC Plan is fully accepted by the Engineer.

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

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

2. The Contractor shall provide additional personnel who are assigned to assist the QA/QC Manager as required to fulfill the requirements of the QA/QC Plan. The Contractor shall provide a copy of the letter to the QA/QC Manager signed by an authorized official of the firm which describes the responsibilities and delegates sufficient authorities to adequately perform the functions of the QA/QC Manager, including authority to stop work which is not in compliance with the contract. The QA/QC Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Engineer.

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

1. The description of the quality control organization shall include a chart showing lines of authority staffing plan and acknowledgment that the QA/QC staff shall implement the system for all aspects of the work specified. The staffing plan shall identify the name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QA/QC function including the QA/QC Manager.

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

E. Identification and Control of Items and Materials: Procedures to ensure that items or materials that have been accepted at the site are properly used and installed shall be described in the QA/QC Plan.

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

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

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

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

3. Procedures shall include:

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

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

i. Dated list of Item(s) inspected
ii. Location of the test sample(s)
iii. Logs, detailed locational drawings and confirmation reports
iv. Quality characteristics in compliance
v. Quality characteristics not in compliance
vi. Corrective/remedial actions taken
vii. Statement of certification
viii. QC Manager’s signature

c. Specific instructions for recording all observations and requirements for demonstrating through the reports that the Work observed was in compliance or a deficiency was noted and action to be taken.

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

e. Procedures for halting or rejecting Work.

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

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

   i. Automatic exception reporting
   ii. Resolution tracking
   iii. Quality Confirmation Test reports
   iv. Sample retention index and storage

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

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

   a. Individual test records containing the following information:

      i. Item tested –item number and description
      ii. Test results
      iii. Test designation
      iv. Test work sheet including location sample was obtained
      v. Acceptance or rejection
      vi. Date sample was obtained
      vii. Retest information, if applicable
      viii. Control requirements
      ix. Tester signature
      x. Testing QC staff initials

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

      i. Dated list of Item(s) inspected
      ii. Location of the test sample(s)
      iii. Logs, detailed location drawings and confirmation reports
      iv. Quality characteristics in compliance
      v. Quality characteristics not in compliance
      vi. Corrective/remedial actions taken
      vii. Statement of certification

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

   d. Maintaining copies of all test results.

   e. Ensuring Engineer receives independent copy of all tests.

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

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

H. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be adequately maintained, calibrated, certified and adjusted to maintain accuracy within prescribed limits. Calibration shall be performed at specified periods against valid standards traceable to nationally recognized standards and documented.

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

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

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

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

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

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

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

e. Personnel responsible for achieving resolution of outstanding deficiencies.

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

K. Special Processes And Personnel Qualifications

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

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

L. Audits

1. The Contractor's QA/QC program shall provide for documented audits to verify that QA/QC procedures are being fully implemented by the Contractor as well as its subcontractors. Audit records shall be made available to the Engineer upon request.

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

M. Documented Control/Quality Records

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

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

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

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

N. Acceptance of QA/QC Plan: The Engineer's review and acceptance of the Contractor's QA/QC Plan shall not relieve the Contractor from any of its obligations for the performance of the Work. The Contractor's QA/QC staffing is subject to the Engineer's review and continued acceptance. The City, at its sole option, without cause, may direct the Contractor to remove and replace the QA/QC representative. No Work covered by the

QA/QC Plan shall start until the Engineer's acceptance of Contractor's QA/QC plan has been obtained.

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

1.07 TESTING SERVICES

A. All tests which require the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to Engineer. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards. All standard quality assurance testing and installation verification testing will be at the expense of the Contractor.

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

C. The Engineer shall have the right to inspect work performed by the independent testing laboratory both at the project and at the laboratory. This shall include inspection of the manual, equipment calibrations, proficiency sample performance, etc.).

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

E. Testing Services Provided by the Contractor

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

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

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

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

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

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

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

b. Slumps, air bucket tests, compression tests and other confirmation tests

c. Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.

d. All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.

7. Testing, including sampling, shall be performed by the Contractor's testing firm's laboratory personnel, in the manner and frequency indicated in the Specifications. The Engineer shall have the right to stipulate the location of the confirmation tests. The Contractor shall provide preliminary representative samples of materials to be tested, to the testing firm's laboratory, in required quantities.

8. The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test.

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

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

F. Transmittal of Test Reports:

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

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

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

+ + + END OF SECTION 01400 + + +

SECTION 01410
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 SCOPE

A. 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.

1.02 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.

1.03 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.

1.04 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).

1.05 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.

1.06 FURNISHING MATERIALS

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

1.07 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.

1.08 CONTRACTOR'S CONVENIENCE TESTING

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

1.09 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 01410 +++

SECTION 01500
TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 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.

C. The ownership of the trailers for Engineer's facilities shall remain with the Contractor. However, all the office furnishings and equipment provided by Contractor under this section of specifications shall remain as City properties. At completion of the Work move all of the office furnishings and equipment to a location designated by the Engineer.

1.02 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.

1.03 CONTRACTOR'S FACILITIES (Revise as needed)

A. Contractor's Plant: Submit a plan of the plant layout to Engineer for approval within 15 days of the Notice to Proceed. Contractor's plant, for purposes of this Section, is defined to include, but is not limited to, its field offices, sanitary facilities, first aid station, storage facilities, and major equipment. Sufficient construction plant 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 plant shall be of sufficient capacity and reliability to permit a rate of progress which will insure completion of the Work within the time stipulated in the Contract. Insufficient, inadequate, improper plant or equipment shall be brought to acceptable condition or shall be removed from the site.

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

B. First Aid Stations: The Contractor shall provide first aid stations and facilities necessary to accommodate all personnel performing work under this Contract. Each station shall be equipped with all facilities and medical supplies necessary to administer emergency first aid treatment. A qualified first aid attendant shall be on duty at each station for each working shift. 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 and Engineer's personnel.

1.04 ENGINEER'S FACILITIES

Engineer's Project Office

1. Within 60 days after receipt of the Notice to Proceed, furnish all materials and equipment necessary for the Engineer's project office, which shall be a pre-fabricated building or a mobile office no smaller than 430 square feet and having ceiling, floor and walls adequately insulated. The facility shall be tied down to meet code requirements. The complex shall have the number of steel doors required to meet building codes, each equipped with a double deadbolt with a pull handle exterior and closer. All partition and closet doors shall be furnished with integral locks. The main entry shall have a covered porch and approach steps and railing built with pressure treated wood. The other entrance(s) shall have a covered porch at least 4 feet square with appropriate steps and railing. The office facility shall be properly skirted using perforated fiberglass skirting material designed to match the exterior of the structure. Also construct additional supports below the floor space occupied by the fireproof filing cabinets. The office shall be secured with tie-downs for 100 mile per hour gusts and winds. The Engineer’s project office shall include all electrical, plumbing, hvac, and safety facilities required by building codes.
2. The office shall have a total minimum window area equal to at least ten percent of floor area. Windows shall each have insect screen and operable sash. Provide each window with lock and exterior security bars approved by Engineer. Lighting fixtures with diffuser covers, in adequate numbers, shall be installed to give minimum illumination of 150 foot candles and minimum glare. Exterior flood lights shall be provided at each exterior entry. 110 volt duplex outlets, 2 above and 1 below the lower cabinet counter top on each wall in each office shall be provided. The office

building shall be adequately wired for electricity in accordance with applicable codes to handle the total lighting, air conditioning, and other loads. Provide air conditioning and heating combination unit(s) to maintain 78 degrees F inside in winter with outside air temperature of 20 degrees F and 72 degrees F inside in summer with outside temperature of 100 degrees F. The HVAC units shall be located at the kitchen/break room end of the facility equipped with an overhead plenum wall return air wall system.

3. Furnish the services of a professional computer system installer to install, connect, and test the various computers, printers, communication equipment, and other peripherals specified in this section. The various cable types, lengths, adapters, and other connectors listed below are approximate and may have to be modified to conform to the project office and equipment layout and to complete the installation as a satisfactorily functioning system. In addition, maximum effort shall be made to terminate the various cables in wall mounted outlets with appropriate connectors to reduce cable clutter and achieve an orderly appearance for the installation. The wall outlets are not listed below.

4. The Contractor shall provide furnishings, fixtures, and equipment, as approved by the Engineer, as follows:

a) Desks: Two 5-drawer desks, each five feet long by 2.5 feet wide with at least one file drawer per desk, suitable for storing 8.5-inch by 11-inch documents.
b) Desk Chairs: Two new or used (in good condition) five-point, high backed, cushioned swivel chairs.
c) Other Chairs: Four side chairs with arm rests and padded seats and backs, and eight metal folding chairs without arm rests.
d) Two new or used (in good condition) folding tables each eight feet long by 2.5 feet wide.
e) Two new or used (in good condition) folding tables each six feet long by 2.5 feet wide.
f) Plan rack(s) to hold minimum of eight sets of the Drawings.
g) Two 4-drawer file cabinets.
h) One 2-door storage cabinet.
i) Shelving or bookcase with a total of 12 feet of shelf length at least 12 inches deep.
j) Four polyethylene waste baskets, each with minimum seven-gallon capacity.
k) Suitable doormat at each exterior ingress/egress door.
l) One tack board 2.5 feet by three feet, with thumbtacks.
m) One white board for use with dry markers, approximately six feet by four feet, with marker holding tray, installed by Contractor at location directed by ENGINEER in the field. Furnish supply of colored markers and eraser for the white board.
n) Fire extinguishers with associated signage, and smoke detector, in accordance with Laws and Regulations. At minimum, for each field office structure, provide two wall-mounted fire extinguishers and one battery operated ceiling-mounted smoke detector.

o) First-aid kit, by Zee Medical Service Co., Item 0125, **"**Kit, Utility, Metal, Full (ANSI)**",** www.zeemedical.com, or approved equal.
p) Temperature and Humidity Monitor: Sensor installed outdoors in shade, display installed inside field office. Unit shall display daily minimum and maximum temperature and current temperature, and be capable of displaying daily minimum and maximum relative humidity and current relative humidity, and have audible alarm and adjustable alarm setpoints. Provide Fisher Scientific "Fisherbrand Remote Alarm RH/Temperature Monitor" Catalog No. S90194, or equal. Provide batteries for unit as required.
q) Six protective helmets for use by Engineer, City, and visitors.
r) Two electric clocks.
s) One electric coffee maker, with ten-cup capacity or larger.
t) Bottled water with electric cooler dispenser for five-gallon bottles, with cup dispenser.

1.05 TELEPHONE SERVICES

General

1. Make all necessary arrangements for outside telephone service to Contractor's office, Engineer's Project Office(s), and the First Aid Station. Telephone communications shall also be provided between the Engineer's Project Office and Site Office of the same location. The connection to Engineer's Facilities shall be consistent with the specified hardware requirements for such facilities. Schematic drawings, showing the complete telephone system to be installed, shall be provided for review by the Engineer before installation of the service. All portions of the communication system shall be maintained in good working condition.
2. All expenditures for installation costs of hardware, lines, line extensions, service changes, and recurring service charges for telephone service shall be paid by the Contractor. The Engineer will reimburse the Contractor for long distance charges made by the Engineer.
3. The telephone system to be installed and maintained for the Engineer's Facilities shall include one cordless telephone with hands-free speaker. Telephone shall have speed dialing with minimum of 20 programmable numbers, volume control, mute, redial, and hold button.
4. Furnish two additional dedicated telephone lines to the Engineer's Project Office. One will be used for a dedicated facsimile machine. The second line will be used for dedicated computer communications with City of Atlanta's networked main frame computer.

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 Engineer's Project Office. The hosebib is to be sized for a standard ½" garden hose connection.

3.03 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 Engineer's facilities for the duration of the project. Cleaning shall be done on a daily basis, to the satisfaction of the Engineer, during other than normal daytime office working hours. These services shall include sweeping, vacuuming, dusting, emptying of trash, cleaning of wash basins, bathroom and shower facilities, daily mopping and monthly waxing of all vinyl floors. Contractor shall also provide for monthly exterminating services of the offices.

3.04 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 Engineer's satisfaction.

+++ END OF SECTION 01500 +++

SECTION 01540
SECURITY AND SAFETY

PART 1 GENERAL

1.01 SECURITY PROGRAM

A. The Contractor shall protect the Work, including all field offices and temporary facilities 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 shall be wholly responsible for the security of their storage and lay down areas and for all their plant, material, equipment and tools at all times.

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

1.02 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. The log shall be submitted to the Engineer bi-weekly or as necessary. Sample logs are included at the end of this section.

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 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.

1.03 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.

1.04 RESTRICTIONS

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

1.05 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 of the plan shall be the responsibility of the Contractor.

B. The Engineer will not review the Contractor's safety plan 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. Included 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 Engineer with documentation to show compliance with their plan, plus accidents and investigation reports.

11. Address any other specific contract requirements.

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 Engineer shall not impose any duty or responsibility upon the 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 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.

1.06 PROJECT SAFETY COORDINATOR

A. The Contractor shall be responsible for the safety of the Contractor's and the City's personnel and all other personnel at the site of the Work. The Contractor shall have a Project Safety Coordinator, as required by the General Conditions, on the job site. The Project Safety Coordinator shall 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, address 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 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 the Engineer of a serious accident immediately, followed by a detailed written report within twenty-four (24) hours. A "serious accident" is defined as an accident requiring an absence from work of more than 2 days and/or hospitalization.

10. Notify the 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.

PART 2 PRODUCTS

(NOT USED)

PART3 EXECUTION

(NOT USED)

+ + + **END OF SECTION 01540 + + +**

(See attached forms)

VISITOR ACKNOWLEDGMENT OF THE PROJECT SITE RULES

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

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

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

PROHIBITED ACTIVITIES

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

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

VISITOR LOG

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

VISITOR'S NAME PRINT	SIGNATURE	COMPANY VISITED	DATE	IN	OUT

EMPLOYEE ACKNOWLEDGMENT OF THE PROJECT SITE RULES

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

PROHIBITED ACTIVITIES

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

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

EMPLOYEE LOG

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

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

SECTION 01550
TRAFFIC REGULATION

PART 1 - GENERAL

1.01 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.

1.02 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 latest edition of 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

2.01 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

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

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

E. 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.

F. 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.

G. 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.

H. 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.

3.02 PREPARATION OF TRAFFIC CONTROL PLANS

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

3.03 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.

3.04 MAINTENANCE OF TRAFFIC

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

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.

3.05 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 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.

3.06 FLAGMEN

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

3.07 FLASHING LIGHTS

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

3.08 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.

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

3.010 PROCEDURES FOR TRAFFIC DETOUR ROUTE PLAN

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

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.

3.10 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.

3.11 REMOVAL

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

+++END OF SECTION 01550+++

SECTION 01600
GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.01 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

2.01 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.
d. Anchors shall develop ultimate shear and pull-out loads of not less than the following values in concrete:

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

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

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.

2.02 CONNECTION BOLTS

A. Materials shall be as specified in other Sections of the Specifications, or as shown on the Drawings. Where materials are not specified or shown on the Drawings, they shall be of ANSI Type 316 stainless steel, with ANSI Type 316 stainless steel nuts and washers.

B. Unless otherwise specified, stud, tap and machine bolts and nuts shall be ANSI Type 316 stainless steel and shall conform to the requirements of ASTM Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307-80. Hexagonal nuts of the same quality of metal as the

bolts shall be used. 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).

2.03 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.

2.04 SLEEVES

A. Unless otherwise indicated on the Drawings or specified, openings for the passage of pipes through floors and walls shall be formed of sleeves of standard-weight, stainless-steel pipe. The sleeves shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be of sufficient length to be flush at the walls and the bottom of slabs and to project 4-in. above the finished floor surface. Threaded nipples shall not be used as sleeves.

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

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

2.05 ELECTRICAL EQUIPMENT ENCLOSURES

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.

2.06 EQUIPMENT DRIVE GUARDS

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

2.07 NAMEPLATES

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

B. This requirement shall not apply to standard, manually operated gate, lobe, check and plug valves.

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

2.08 LUBRICANTS

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

2.09 PROTECTION AGAINST ELECTROLYSIS

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

2.10 TRANSPORTATION, HANDLING, STORAGE AND PROTECTION

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:

C. 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.

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

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

F. 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.

2.11 UNIT RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. Unless otherwise specified, the Contractor shall obtain each system from the supplier of the driven equipment, 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 executed by the manufacturer. No other submittal material shall be processed until the Certificate of Unit Responsibility has been received and has been found to be satisfactory. A typical Manufacturer's Certificate of Unit Responsibility form is included in this specification.

2.12 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Where manufacturers' services are specified, Contractor shall furnish a qualified representative of the manufacturer to provide these services. Where time is necessary in excess of that stated in the Specifications for the manufacturers' service representative to complete the specified services, the additional time required to perform the services shall be considered incidental work for which the Contractor will receive no additional compensation.

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 N of this paragraph and a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

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. Definitions

For purposes of furnishing manufacturers' services, refer to Section 01664, Manufacturers’ Services and the following definitions shall apply:

a. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.
b. Construction Period: The time period from the Contractor's purchase order date to the date of certification by the manufacturer that the material or equipment is properly installed and that functional and performance tests, as applicable to the equipment specified, have been successfully demonstrated.
c. Man-Day: One man for 8 hours straight time, exclusive of Saturdays, Sundays, or holidays.

H. 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.

I. 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.

J. 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.

K. 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.

L. Training of City's Personnel

1. Contractor's Personnel: Designate and provide Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Engineer and shall be familiar with the Operation and Maintenance (O & M) Manual information specified in the General Conditions of the Contract Documents.
2. Manufacturer's Representative: Where training of City's personnel is required in the Specifications, furnish manufacturer's representative to provide detailed instructions to City's personnel for operation and maintenance of the specified equipment.
   a. Training services include pre-startup classroom instruction, post-startup classroom instruction, and onsite equipment instruction, as stated in the Specifications.
   b. Manufacturer's representative shall be familiar with plant O & M requirements as well as with the specified equipment.
3. 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 before startup.
4. 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.

M. 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: _____

+ + + END OF SECTION 01600 + + +

SECTION 01610
TRANSPORTATION AND HANDLING

PART 1 GENERAL

1.01 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.

1.02 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.

1.03 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 01610 +++

SECTION 01640
MANUFACTURERS' SERVICES

PART 1 - GENERAL

1.01 DEFINITIONS

A. Reference Section 01650, Facility Startup.

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

1.02 SUBMITTALS

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

1. Preliminary Training Plan: Submit within 120 days after Notice to Proceed.
2. Training Schedule: Submit not less than 30 days prior to start of equipment installation and revise as necessary for acceptance.
3. Final Training Plan: Submit after training coordination meeting.
4. Training Materials:

    a. Submit written outlines of proposed training sessions not less than 30 days prior to scheduled training.
    b. Furnish complete training materials, to include operation and maintenance data as required in this section . Provide 12 extra copies of all training materials to Owner.
    c. Quality Control Submittals: When specified in the individual Specifications, submit:
    d. Qualifications and resume of Manufacturer's Representative performing specified services.
    e. Manufacturer's Certificate of Proper Installation: On form appended to this section.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. Additional qualifications may be specified elsewhere.

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

1.04 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Where manufacturers' services are specified, furnish manufacturer's qualified representative. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work.

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

1. Determine that all conditions necessary to allow successful testing have been met before scheduling services.
2. Only those days of service approved by Engineer will be credited to fulfill the specified minimum services.
3. If specified, manufacturer's onsite services shall be 8 hours minimum and include as a minimum:
4. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
5. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish written approval of installation.
6. Revisiting the site as required to correct problems and until installation and operation are acceptable to Engineer.
7. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
8. Assistance during functional and performance testing and startup demonstration, and until product acceptance by the Owner.
9. Training of Owner's personnel in the operation and maintenance of respective product as required.
10. Completion of Manufacturer's Certificate of Proper Installation (form enclosed at end of this section) with applicable certificates for proper installation and initial, interim, and final test or service.
11. Additional requirements which may be specified elsewhere.

1.05 TRAINING PLAN

A. Preliminary Training Plan: If specified, and within 120 days after Notice of Award, submit for each proposed course:

1. Title and objectives.
2. Training schedule.
3. Prerequisite training and experience of attendees.
4. Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
5. Course description and outline of course content.

6. Duration.
7. Location (e.g., training center or site).
8. Format (e.g., lecture, self-study, demonstration, hands-on).
9. Instruction materials and equipment requirements.

B. Final Training Plan: Submit the following after training coordination meeting, if specified.

1. Updated versions of course descriptions from preliminary training plan.
2. Who will attend each course.
3. Schedule of training courses including dates, durations, and locations of each class.
4. Detailed course schedule for each day showing time allocated to each topic.
5. Resumes of instructors providing the training.

1.06 TRAINING SCHEDULE

A. List specified equipment and systems with respective manufacturers that require training services of manufacturers' representatives and show:

1. Estimated dates for installation completion.
2. Estimated training dates to allow for multiple sessions when several shifts are involved.

B. Adjust training schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

C. Coordinate with Progress Schedules as specified in Special Conditions and Section 01650, FACILITY STARTUP.

1.07 TRAINING CITY'S PERSONNEL

A. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information.

B. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.

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

D. Pre-startup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives.
2. Complete at least 7 days, but no more than 14 days, prior to actual startup.

E. Post-Startup Training: Furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives. Manufacturer's representative shall be required for a follow-up visit of one day.

F. Taping of Training Sessions: The Owner will provide audio/video taping of all training sessions. Manufacturer's trainer is to provide appropriate props, such as, charts, photographs and samples in large enough sizes to be video taped. All trainers are to provide their full cooperation to the Owner's video technician.

1.08 SUPPLEMENTS

The supplements listed below, following "END OF SECTION," are part of this Specification.

1. Manufacturer's Certificate of Proper Installation.
2. Manufacturer's Instruction Certification Form.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

CITY OF ATLANTA (Spec Writer - Insert Project Name)
MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO:_____

EQPT TAG NO:_____ EQPT/SYSTEM:_____

PROJECT NO:_____ SPEC. SECTION:_____

SITE LOCATION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

☐	Installed in accordance with Manufacturer's recommendations.
☐	Inspected, checked, and adjusted.
☐	Serviced with proper initial lubricants.
☐	Electrical and mechanical connections meet quality and safety standards.
☐	All applicable safety equipment has been properly installed.
☐	System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)
☐	System has been started up and meets or exceeds performance requirements.

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date:_____

Manufacturer:_____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

CITY OF ATLANTA (Spec Writer - Insert Project Name)
MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No.: _____
Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment Item: _____

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

Operations Check List (check appropriate spaces)

Startup procedure reviewed _____
Shutdown procedure reviewed _____
Normal operation procedure reviewed _____

Others: _____

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency) _____
Described special tools required _____
Described normal items to be reviewed for wear _____
Described preventive maintenance instructions _____
Described greasing frequency _____

Others: _____

Date Manufacturer

_____ _____
Date Signature of Authorized Representative

_____ _____
Date Signature of City's Representative

_____ _____
Date Signature of Contractor's Representative

+++ END OF SECTION 01640 +++

SECTION 01650
FACILITY STARTUP

PART 1 - GENERAL

1.1 RELATED SECTIONS

The follow specifications are related to this specification: 01640, Manufacturers' Services; 01664, Training; 02665, Water Mains and Accessories; 03300, Cast-In-Place Concrete; 13000, Instrumentation, Control, and Monitoring System General Requirements; 13200, General Requirements for Process Instrumentation Systems; 13212, Transmitters; and 15060, Piping and Appurtenances.

1.2 DEFINITIONS

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

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

B. Functional Test: (Step 2): A test or tests, in the presence of the Engineer and Owner, 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 Engineer and Owner, of all components within a system collectively to insure that the system and all of its

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

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 Owner'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 Engineer and Owner, 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 as identified in the Engineer's certification, has been properly installed per the contract documents and manufacturer recommendations, deemed operational through the completion of the Pre-operational checkout, Functional Test, Operational Test, has all test documents with Operation and Maintenance manuals delivered, is sufficiently completed in accordance with the requirements of the Contract Documents and has been demonstrated through the 30 day Acceptance Test thus proving that the identified portion of the work can reliably be utilized for the purposes for which it is intended.

1.3 SUBMITTALS

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 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, the Engineer and the Designer must be held at least 7 days prior to the commencement of the modification or tie-in. The day before the commencement of the modification or tie-in, a final coordination meeting shall be held giving final detailed work assignments to all parties involved.

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

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 – 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.

C. 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.

D. 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:

E. 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 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 and 2 inch	3 psi or less	Air or water
Greater and 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.
3. 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.
4. 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 Design/Build Improvements, the contractor shall perform Acceptance Testing. Acceptance Testing and the Acceptance Test Plan shall comprehensively cover all potential modes of operation, including failure scenarios, as well as the operation of ancillary systems, to demonstrate full functionality of the Improved Facilities. Any failures of process, equipment or systems shall result in re-starting the acceptance testing period. The testing period shall be a minimum of 30 days of continuous operation, during which the facility must meet the following criteria:
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 insitu using either the total count or dye dilution methods. Gas flow meters installed in piping systems with diameters greater than 6 inches shall be calibrated insitu using the pitot tube velocity averaging method. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five confirmed valid data points shall be obtained within this range and witnessed by a City Engineer. Confirmed data points shall be validated by not less than three test runs with results which agree within plus or minus 2 percent.

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

1.01 DESCRIPTION

A. Reference Sections 01640, Manufacturers' Services, 01650, Facility Startup and 13000 Instrumentation, Control and Monitoring System General Requirements.

B. 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.

1.02 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.

1.03 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.

1. Lesson plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

2.01 GENERAL

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.

2.02 LOCATION

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

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

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

2.04 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:

1. Familiarization:
   a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
   b. Check out the installation of the specific equipment items.
   c. Demonstrate the installed unit and indicate how all parts of the specifications are met.
   d. Answer questions.
2. Safety:
   a. Using material previously provided and installed equipment, review safety references.
   b. Discuss proper precautions around equipment.
3. Operation:
   a. Using material previously provided and installed equipment, review reference literature.
   b. Explain all modes of operation (including emergency).
   c. Check out City's personnel on proper use of the equipment.
4. Preventive Maintenance:

a. Using material previously provided and installed equipment, review preventive maintenance (PM) lists including:
    1. Reference material.
    2. Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.
b. Show how to perform PM jobs.
c. Show City's personnel what to look for as indicators of equipment problems.

5. Corrective Maintenance:
    a. List possible problems.
    b. Discuss repairs; point out special problems.
    c. Open up installed equipment and demonstrate procedures, where practical.
6. Parts:
    a. Show how to use previously provided parts list and order parts.
    b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
7. Local Representatives:
    a. Where to Order Parts: Name, address, and telephone.
    b. Service Problems:
        1. Who to call.
        2. How to get emergency help.
8. Operation and Maintenance Manuals:
    a. Review any other material submitted.
    b. Update material, as required.

2.05 VIDEO RECORDING

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

PART 3 – EXECUTION

3.01 GENERAL

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The CONTRACTOR shall arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Contractor/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. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum classroom equipment training for operations personnel will include:
   a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
   b. Purpose and plant function of the equipment.
   c. A working knowledge of the operating theory of the equipment.
   d. Startup, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.
   e. Identify and discuss safety items and procedures.
   f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.
   g. Operator detection, without test instruments, of specific equipment trouble symptoms.
   h. Required equipment exercise procedures and intervals.
   i. Routine disassembly and assembly of equipment if applicable (as judged by the City on a case-by-case basis) for purposes such as operator inspection of equipment.
2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      1) Location of primary element.
      2) Location of instrument readout.
      3) Discuss purpose, basic operation, and information interpretation.
   e. Discuss, demonstrate, and perform standard operating procedures and routine checks.
   f. Discuss and perform the preventative maintenance activities.
   g. Discuss and perform startup and shutdown procedures.
   h. Perform the required equipment exercise procedures.
   i. Perform routine disassembly and assembly of equipment if applicable.
   j. Identify and review safety items and perform safety procedures, if feasible.
3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Startup and shutdown procedures.

d. Normal and major repair procedures.
e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
f. Routine and long-term calibration procedures.
g. Safety procedures.
h. Preventative maintenance such as routine lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform startup and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform City approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

+ + + END OF SECTION 01664 + + +

SECTION 01780

ASSET MANAGEMENT RECORDS

PART 1 - GENERAL

1.01 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).

1.02 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)

1.03 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.

1.04 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).

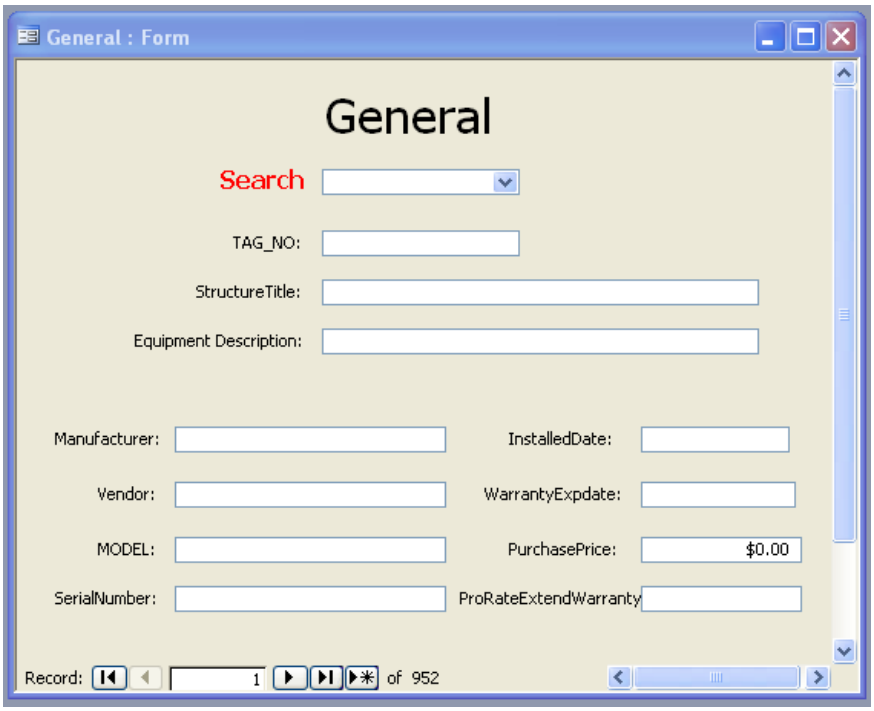
F. The Contractor shall submit to the Engineer, a draft of the Asset – CMMS Spreadsheet for each structure or portion of the Project, by the 50% construction complete stage of the structure or portion of the Project, for review as to form and completeness of the asset list. If requested by the Engineer, 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).

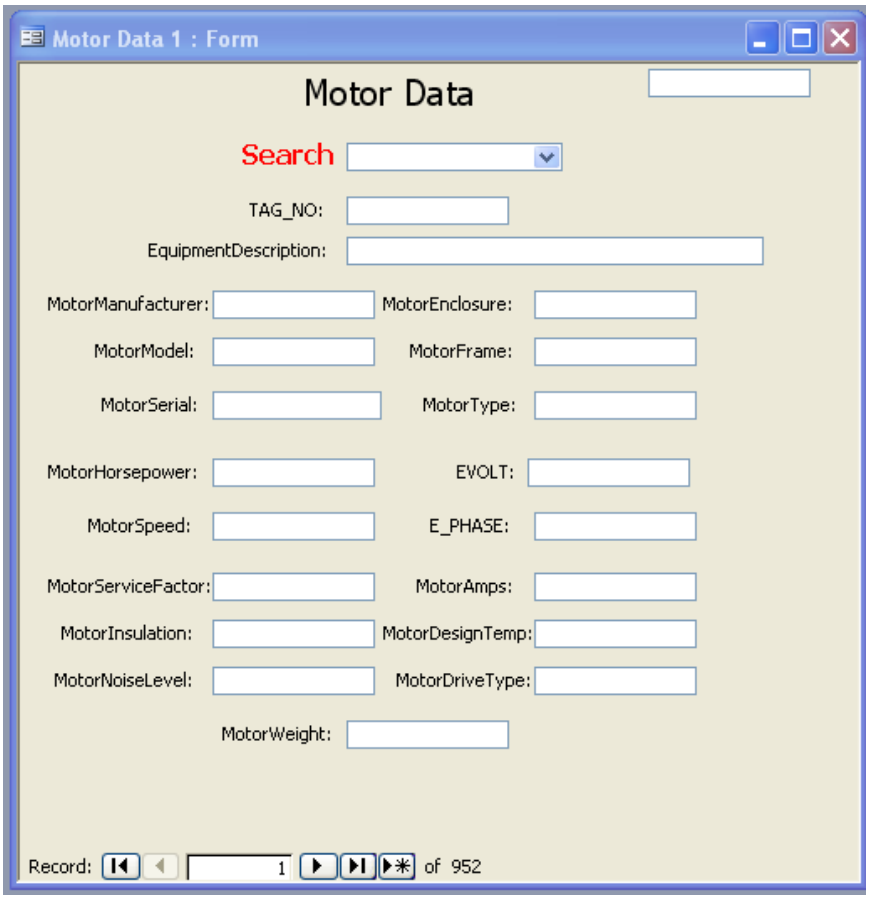
G. After an O&M has been accepted with no exceptions taken, the preventative maintenance detailed in the O&M manual shall be entered in an Excel spreadsheet for importation into the City's CMMS. The Contractor will submit copies of the spreadsheet as part of the CMMS Spreadsheet submittal as a work in 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.

1.05 EXAMPLES OF TYPICAL DATA AND SUGGESTED DATABASE TABLES:

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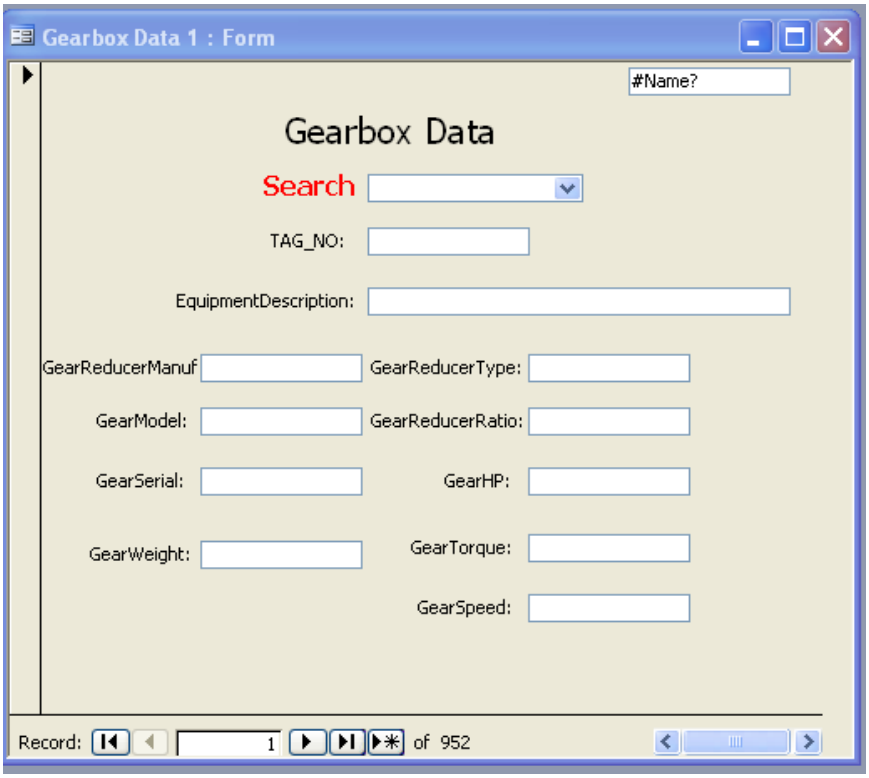
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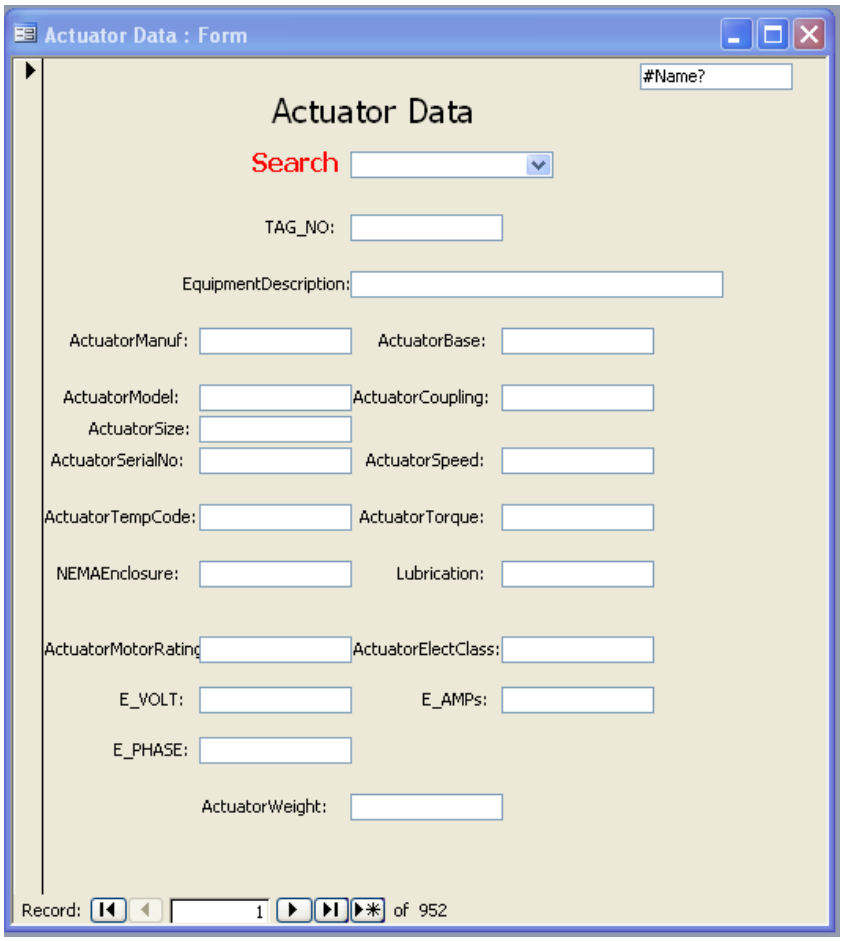
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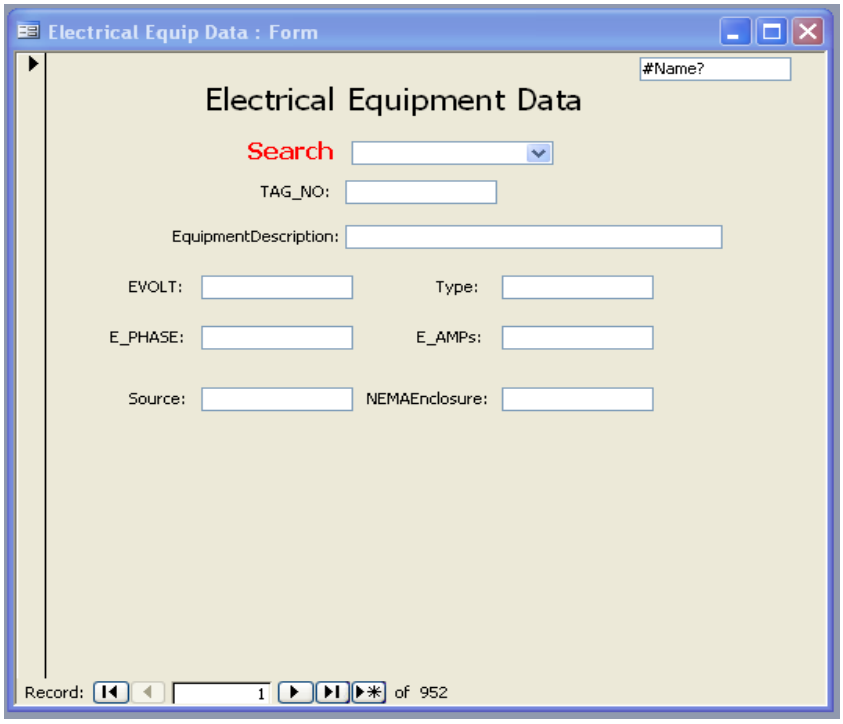
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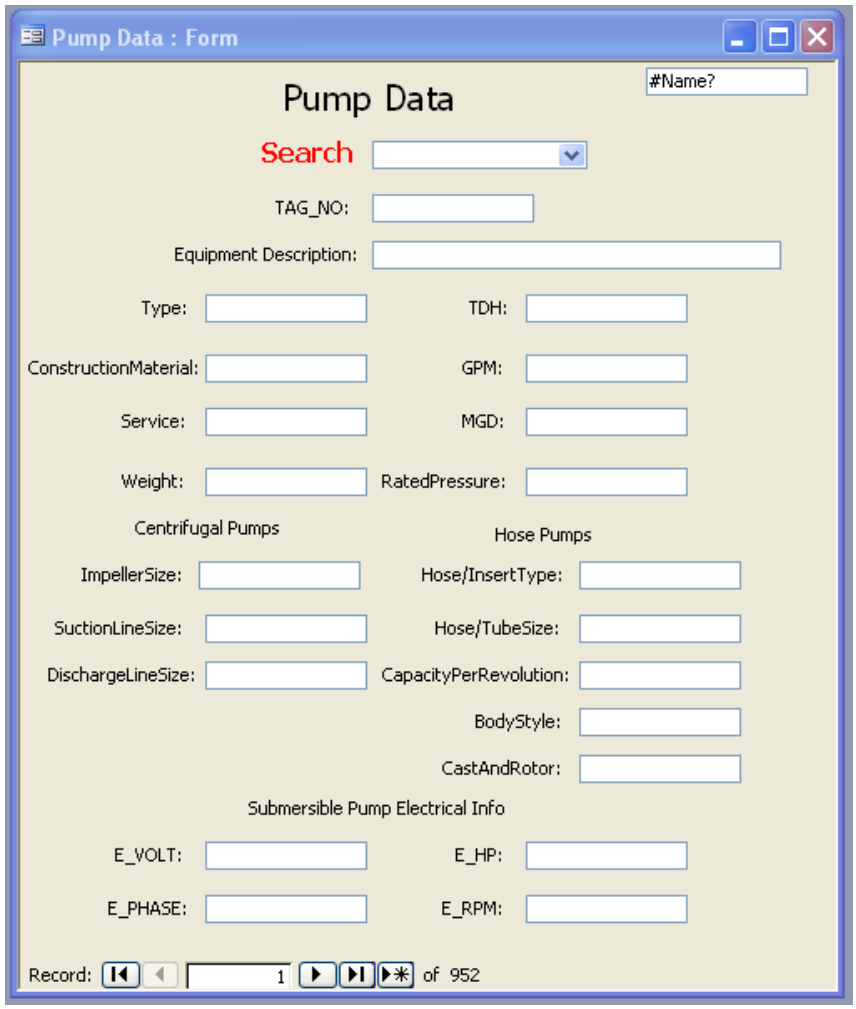
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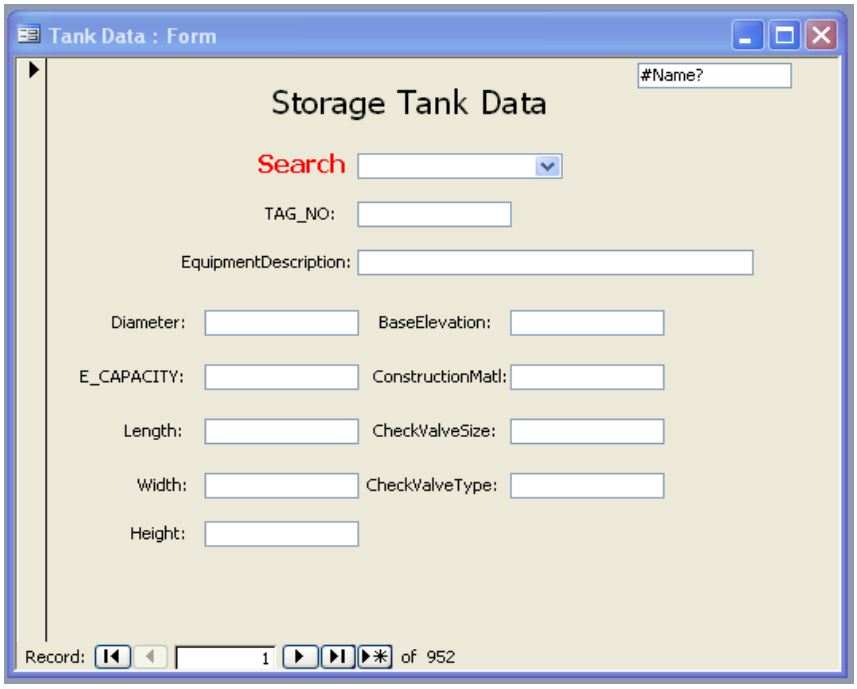
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ConstructionMatl:
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Width:
CheckValveType:
Height:
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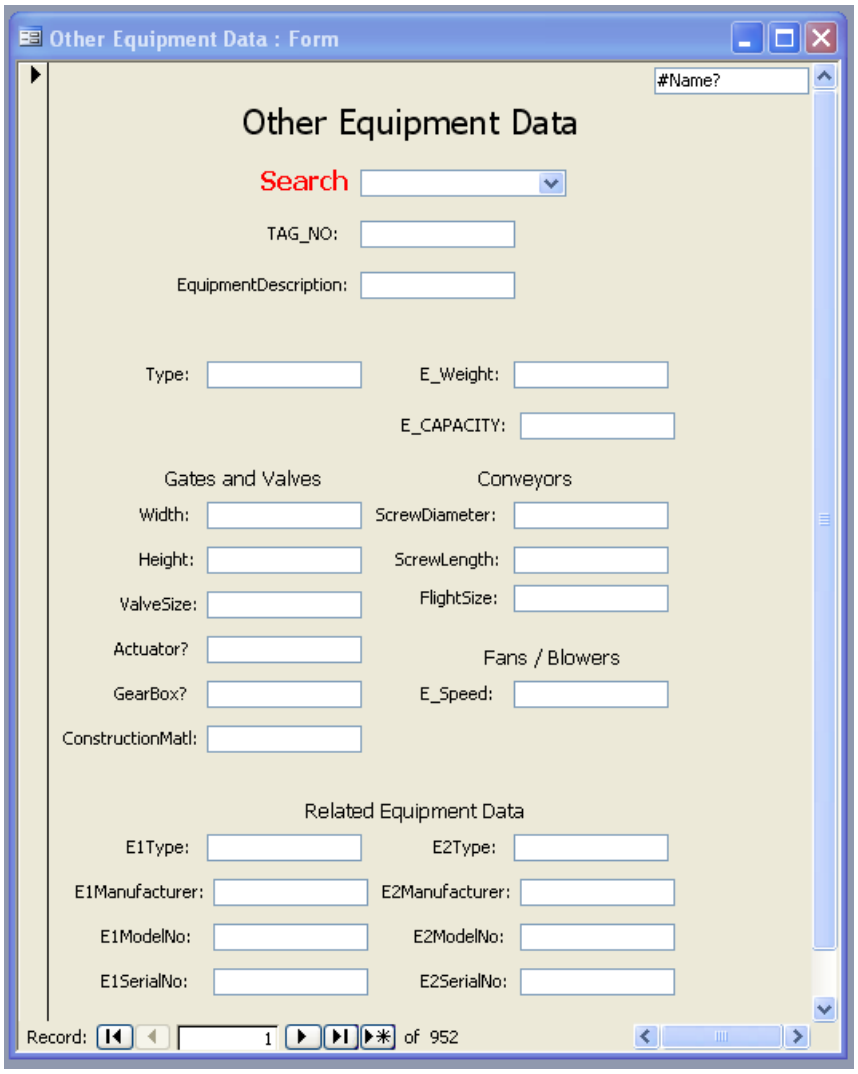
of 952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Actuator?
GearBox?
ConstructionMatl:
Conveyors
ScrewDiameter:
ScrewLength:
FlightSize:
Fans / Blowers
E_Speed:
Related Equipment Data
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E1Manufacturer:
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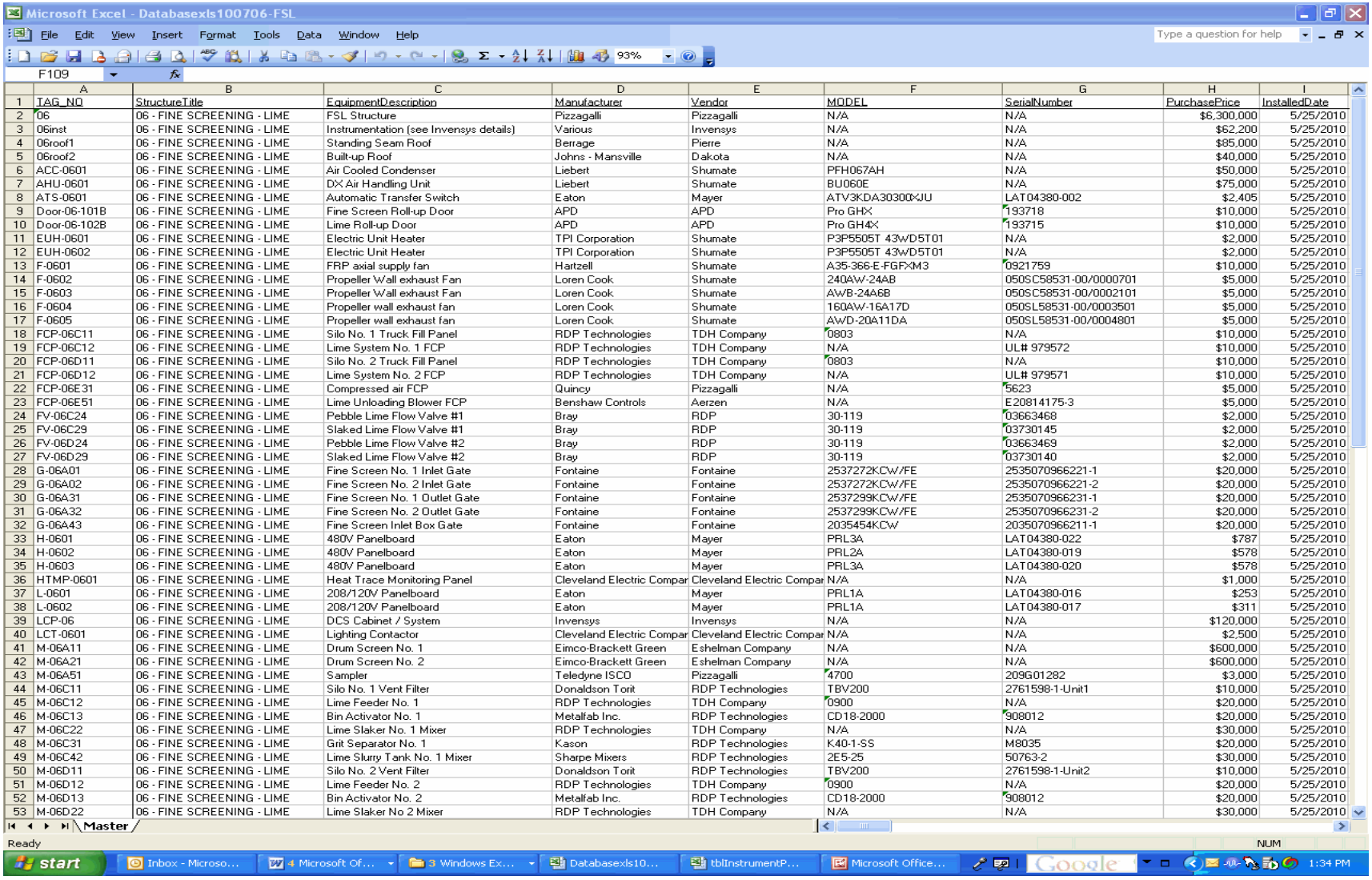
of 952

1.06 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	ATV3KDA30300XJU	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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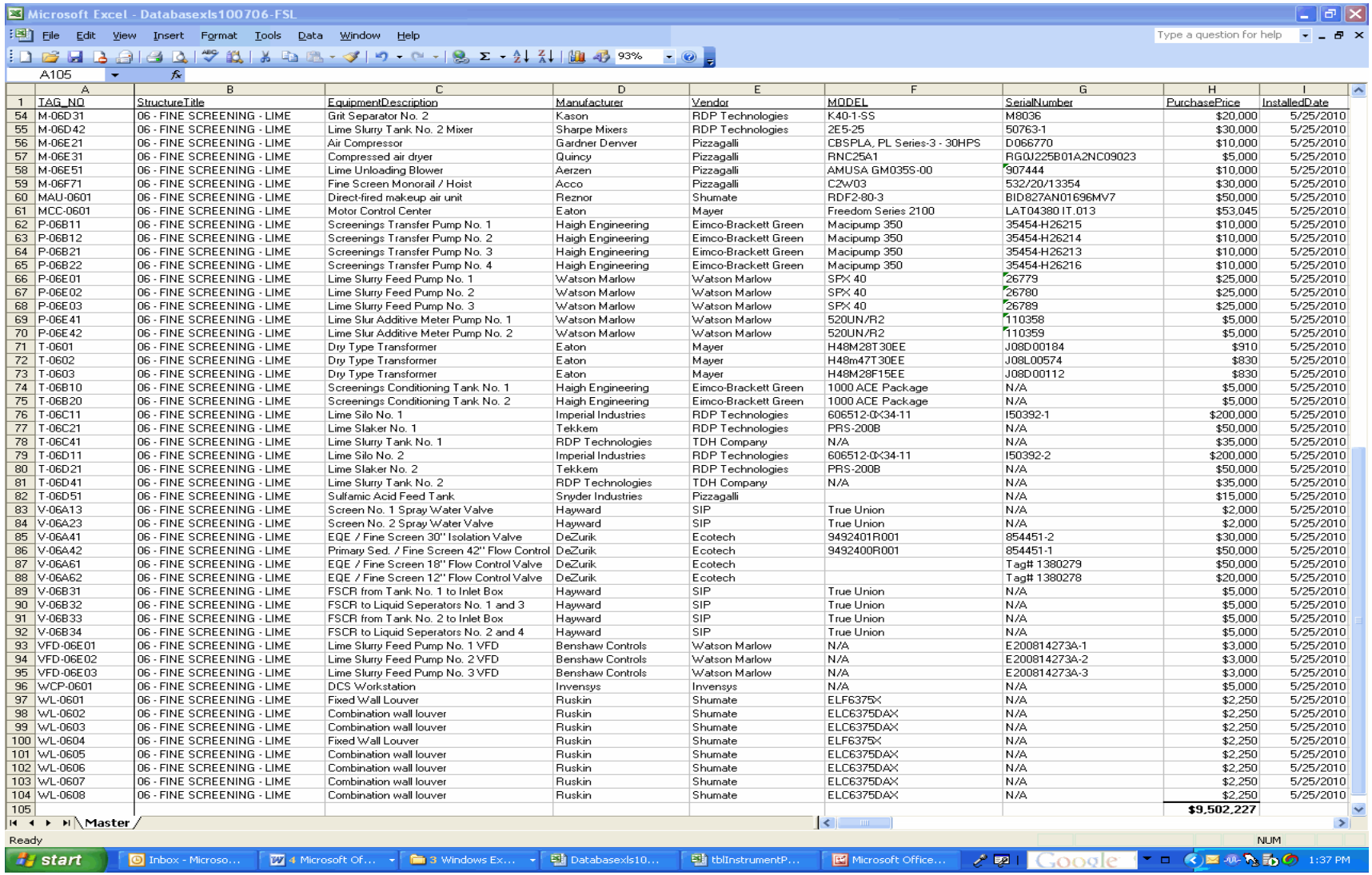
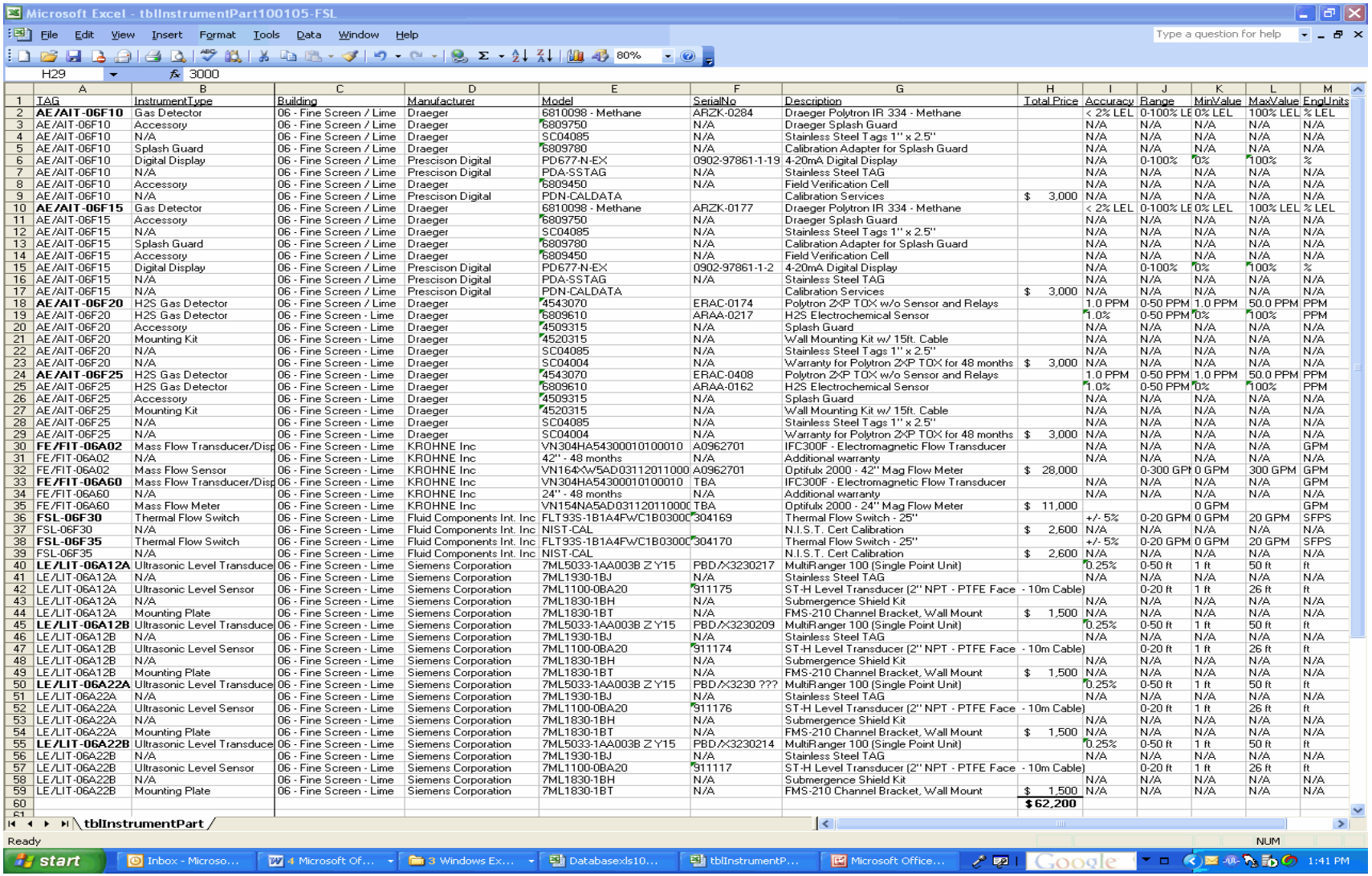


	A	B	C	D	E	F	G	H	I
1	TAG_NO	StructureTitle	EquipmentDescription	Manufacturer	Vendor	MODEL	SerialNumber	PurchasePrice	InstalledDate
54	M-06D31	06 - FINE SCREENING - LIME	Grit Separator No. 2	Kason	RDP Technologies	K40-1-SS	M8036	$20,000	5/25/2010
55	M-06D42	06 - FINE SCREENING - LIME	Lime Slurry Tank No. 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	RGUJ225B01A2NC09023	$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	


Microsoft Excel - tblInstrumentPart100105-FSL

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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-1B1A4FWC1B0300	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-1B1A4FWC1B0300	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

1.01 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 continued 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 01800 + + +

SECTION 02000
SITE WORK

PART 1 - GENERAL

1.01 DESCRIPTION

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

1.02 QUALITY ASSURANCE

A. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1.03 PROJECT CONDITIONS

A. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.

B. Arrange for disconnection and seal or cap all utilities and services designated to be removed before 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 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

2.01 MATERIALS AND EQUIPMENT

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

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine the areas and conditions under which site work is performed. Do not proceed with the work until unsatisfactory conditions are corrected.

B. Consult the records and drawings of adjacent work and of existing services and utilities which may affect site work operations.

+++ END OF SECTION 02000 +++

SECTION 02050
DEMOLITION

PART 1 - GENERAL

1.01 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, directed by the Engineer or required for the completion of the Work, including all necessary excavation and backfilling.

B. Where structural tile and brick is 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 not to remain in service in the finished work, whether or not shown on the Drawings and/or specified herein.

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 as specified in Section 02200, Earthwork.

G. Buildings, facilities, and utilities to be selectively demolished are listed below. This is a condensed list intended to provide an overview of the selective demolition requirements of the project. As the list is not all inclusive, it must be complemented by a careful review of the Drawings and thorough site visits and inspections.

(This is an example. Modify for specific project).

Facility	Description
Manifold and Bypass Piping	Pump Station manifold and bypass piping, valves, fittings, flow meters, and hydrants.
Check Valve Station Piping	Below grade check valves and associated valves for isolation and bypass of the check valves.
Pump Station Building	Limited demolition of glass façade and minor demolition associated with structural modifications to accommodate above grade piping.

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; air, 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, Special Project Procedures.

1.02 SUBMITTALS

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

1. 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.
2. The Contractor shall develop and submit a demolition plan which includes a demolition schedule comparable to a room finish schedule that covers:

    a. Each building surface affected by demolition.
    b. Proposed method and materials for demolition and patching.
    c. Catalog cuts and samples of the materials to be used.

PART 2 - PRODUCTS

2.01 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

3.01 GENERAL

A. Shutdown of Existing Operations and Utilities

1. The existing Water Reclamation Center 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 01100, Special Project Procedures.
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.

3.02 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 girding 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 A706.

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.

3.03 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.

3.04 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.

3.05 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 will 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.

3.06 DISPOSAL

Disposal: All rubble and waste material shall be removed from each work area in order to provide a clean area for pump station and distribution piping 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 other 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.

3.07 DISPOSITION OF SALVAGEABLE MATERIALS

A. The Contractor shall coordinate salvageable materials with the City. Materials and equipment to remain City's property shall be carefully removed and appropriately handled by Contractor to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site (or other site specified in the Contract Documents) at place designated by Engineer or Owner.

B. The equipment and material to be salvaged, as the work proceeds 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.

3.08 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 02050 +++

SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for all clearing and grubbing including, but not limited to, the removal from the Site of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the surface of the ground in the construction area and understood by generally accepted engineering practice not to be suitable for construction of the type contemplated.

B. The extent of route clearing is that minimum degree of clearing necessary to carry out all construction activities including construction of appurtenances and other additional clearing needed for access purposes.

C. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control requirements.

D. Clearing operations include, but are not limited to, the following:

1. Protection of existing trees and other vegetation
2. Removal of trees and other vegetation
3. Clearing
4. Removing above-grade improvements
5. Removing underground improvements
6. Restoring damaged improvements
7. Protecting above-grade and underground improvements
8. Erosion control of disturbed areas

E. Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. Section 02125, Temporary and Permanent Erosion and Sediment Control.
2. Section 02050, Demolition.
4. Section 02200, Earthwork.

1.02 JOB CONDITIONS

A. Protection of Existing Improvements:

1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing improvements.
2. Protect improvements on adjoining properties as well as those on the project site. Restore improvements damaged by this work to their original condition, as

acceptable to the Engineer. Replace property line monuments (such as iron pins) removed or disturbed by clearing operations under the direction of a Land Surveyor licensed in the State of Georgia.

B. Protection of Existing Trees and Vegetation:

1. Protect existing trees and other vegetation to avoid cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip lines, foot or vehicular traffic, and parking of vehicles or equipment within 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

3.01 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.

3.02 CLEARING AND GRUBBING

A. Clearing operations shall begin no more than seven days before beginning construction work for any area.

B. Materials to be cleared, grubbed and removed from the project site include but are not limited to vegetation, trees, stumps, roots, lawns, shrubbery, gardens, paving, miscellaneous structures, debris, and abandoned utilities to the minimum practicable extent to complete the work. Limit clearing to a single lane work route without provision for construction vehicles to pass utility operation. Determine and stake limitations of construction easement or right-of-way prior to commencement of work and keep construction activity within such limits.

C. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all areas to be graded so that topsoil is free of roots and debris. Topsoil is to be left

sufficiently clean so that further picking and raking will not be required.

D. All stumps, roots, foundations and planking embedded in the ground shall be removed and disposed of. Stumps and roots larger than 1 inch shall be grubbed and removed to a depth not less than 4 feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material. Piling and butts of utility poles shall be removed to a minimum depth of two feet below the limits of excavation for structures, trenches and roadways or two feet below finish grade, whichever is lower.

E. Landscaping features shall include, but are not necessarily limited to: fences, cultivated trees, cultivated shrubbery, property corners, man made improvements, subdivision and other signs shall be moved off the easement. The Contractor shall take extreme care in moving landscape features and shall reestablish these features as directed by the Engineer

F. Surface rocks and boulders shall be grubbed from the soil and removed from the site or used as fill in accordance with Section 02200, Earthwork.

G. Where the tree limbs interfere with utility wires, or where the trees to be 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, 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, stripping sod and underlying topsoil, and stockpiling for use in restoring the surface area. Water sod and otherwise maintain sod in viable, growing condition. Alternative means of lawn sod replacement may be approved by the Engineer.

N. Remove above-grade structures only where shown on the Drawings or as authorized by the Engineer.

3.02 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 per-cent standard Proctor.

3.03 DISPOSAL OF WASTE MATERIALS

A. Disposal General Requirements: Dispose cleared matter daily so as to maintain site in a safe and neat condition throughout the contract period. Owners of the property may remove merchantable timber, buildings or other items from the work site before the Contractor begins operations, and no assurance exists that any such material will be on the work site when the Contractor begins work.

B. The debris resulting from the clearing and grubbing operation shall be hauled to 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.

3.04 CONSTRUCTION ACCESS ROUTE ON EASEMENT

A. When shown on the Drawings or directed by the Engineer, a construction access route shall be built for the purpose of accessing and performing all necessary work within the easement.

B. Construction access route shall be cut (10) ten feet wide, minimum, and (6) six inches deep below existing grade. Filter fabric shall be placed at the bottom of the cut, and surge stone shall be placed on top of the fabric, filling the six inch depth along the roadway.

C. The filter fabric for use under the stone shall be as specified in Section 02125, Temporary and Permanent Erosion and Sedimentation Control.

D. Surge stone shall be 4” to 6” size (4X6) rip rap type stone, or equivalent. Use sound, tough, durable stones resistant to the action of air and water. Slabby or shaley pieces will not be acceptable. Specific gravity shall be 2.0 or greater. Stones shall have less than 66 percent wear when tested in accordance with AASHTO T-96.

3.06 TREE REMOVAL ON EASEMENTS

A. The contractor shall confirm ownership of all on-site trees within the easement before work commences 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 02110 +++

SECTION 02125
TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 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.

1.02 SUBMITTALS

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

1.03 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 PRODUCTS2.01 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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.

2.06 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

3.01 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.

3.02 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.

3.03 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.

3.04 EROSION CONTROL

A. Grassing

1. Grassing shall be as specified in paragraph 3.05 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 14 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.

3.05 GRASSING

A. General:

1. Refer to Section 02933, Seeding for detailed specifications on permanent seeding.

2. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition.
3. Specified permanent grassing shall be performed at the first appropriate season following establishment of final grading in each section of the site.
4. All references to grassing, unless noted otherwise, shall relate to establishing permanent vegetative cover as specified herein for seeding, fertilizing, mulching, etc.
5. Permanent grassing shall be of a perennial species.

B. Grassing activities shall comply with Section 02933, Seeding and the Manual for Erosion and Sediment Control in Georgia, specifically for the selection of species, planting dates and application rates for seeding, fertilizer and mulching. Where permanent vegetative cover (grassing) cannot be immediately established (due to season or other circumstances) the Contractor shall provide temporary vegetative or mulch cover.

3.06 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.

3.07 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 02125 + + +

SECTION 02140
DEWATERING

PART 1 – GENERAL

1.01 SCOPE:

A. Construct all permanent Work in areas free from water. Design, construct and maintain all dikes, levees, cofferdams 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

3.01 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.

3.02 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, to insure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures.

D. No separate payment will be made for dewatering required to accomplish the work.

+++ END OF SECTION 02140 +++

SECTION 02200
EARTHWORK

PART 1 – GENERAL

1.01 SCOPE

A. The work under this Section includes earthwork and related operations, including, but not limited to; excavating all classes of material encountered; trenching; handling; storage; transportation; and disposal of all excavated and unsuitable material; construction of fills and embankments; backfilling around structures; backfilling all pits; compacting; all sheeting; shoring and bracing; preparation of subgrades; surfacing and grading; and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the Work.

B. The Contractor shall provide all services, labor, materials, and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing complete Work as shown on the Drawings or specified in these Contract Documents.

C. Related Work specified elsewhere:

1. Section 01410 – Testing Laboratory Services
2. Section 02125 - Temporary and Permanent Erosion and Sedimentation Control
3. Section 02140 - Dewatering
4. Section 02200 – Earthwork

1.02 GENERAL

A. Safety: Comply with local regulations and with provisions of the “Manual of Accident Prevention in Construction” of the Associated General Contractors of America, Inc. Occupational Safety and Health Act (OSHA) and all other applicable safety regulations.

B. The elevations shown on the Drawings as existing are taken from the best available data and are intended to give reasonable information about the existing elevations. The Contractor shall verify conditions to determine the exact quantities of excavation and fill required.

C. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.

D. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the 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.

1.03 SUBMITTALS

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

A. Copies of permits obtained by the Contractor for the work.

B. Test results, certification of compliance, source and samples for all imported materials.

C. Samples of fill materials to be used. Samples shall be submitted 2 weeks in advance of use and shall consist of 0.5 cubic feet of each type of material.

D. Test reports for compaction.

1.04 QUALITY ASSURANCE

Reference Standards. Comply with all Federal, State and local laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

A. ASTM C136-84a, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D1556-82, Test Method for Density of Soils in Place by the Sand Cone Method.

C. ASTM D1557-78, Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.5-kg) Rammer and 18-in. (457-mm Drop).

D. ASTM D3107-88, Test Method for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 – PRODUCTS

2.01 MATERIALS

A. Earthwork Materials
   1. Controlled Fill:
      a. Proposed fill soils shall be laboratory tested prior to construction use to determine their suitability. All fill material shall be subject to the approval of the Engineer.
      b. Notification: For approval of imported fill material, notify the Engineer and Testing Laboratory at least three (3) weeks in advance of intention to import material, designate the proposed borrow area, and permit the Testing Laboratory to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. Test results shall be submitted to the Engineer for approval. All fill shall

be free of organic matter or debris, have a low to moderate plasticity, (PI≤15) uniform composition, and be free of rock fragments greater than three inches in dimension. Soils selected for use as fill material shall also have a standard Proctor (ASTM D 698) maximum dry density of at least 90 pounds per cubic foot.

c. All on-site fill material shall be soil exclusive of organic matter, frozen lumps or other deleterious substances.

d. It shall contain no rocks or earth clumps over 3-inches maximum in dimension.

2. Structural Fill and Structural Backfill:

a. Select on site materials may be suitable. Testing and recommendation of suitability shall be made by the Testing Laboratory and submitted by the Contractor to the Engineer for approval.

b. Imported material shall be sand, uniformly graded crushed rock or other select material recommended by the Testing Laboratory and submitted by the Contractor to the Engineer for approval.

c. Crushed Rock: Crushed rock used for bedding and drainage stone shall conform to the Georgia Department of Transportation Standard Specifications for construction of Road and Bridges, Section 800 for No. 57 Stone.

3. Coarse Aggregate: Coarse aggregate shall conform to the Georgia Department of Transportation Standard Specifications of Transportation Systems construction of Road and Bridges, Section 800 for No. 57 Stone, Group II, and shall have the following gradation:

Sieve size	**Percent Passing**	
1-½ inch	100	-
1 inch	95	100
¾ inch	-	-
½ inch	25	60
3/8 inch	-	-
#4	0	10
#8	0	5

4. 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

3.01 GENERAL

A. Benching of Slopes: When the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when the embankment is to be built ½ width at a time, the slopes that are steeper than 4:1 as measured at right angles to the embankment shall be continuously benched over those areas as the work is brought up in layers. Benching shall be of sufficient width to permit the operation of placing and compacting equipment. Each successive cut shall begin at the intersection of the original ground and the vertical side of the previous cut. Material thus cut shall be recompacted along with the new embankment material. Proof roll subgrade prior to placement of fill material.

B. Topsoil:

1. Remove all topsoil to a depth at which subsoil is encountered, from all areas, which are to be cut to lower grades or filled.
2. Topsoil to be used for finish grading may be stored on the site. It shall be piled properly, sloped to drain and covered.

C. Bracing and Sheeting:

1. Furnish, install, and maintain all sheeting, bracing, and shoring as may be required to properly support the sides of all excavations and to prevent all movement of earth, which could in any way injure the work, adjacent property, or workmen.
2. Properly support all trenches for duct bank installation so as to conform to all pertinent rules and regulations and these Specifications. All trenches deeper than 5 feet shall be shored unless cut to the angle of repose of the excavated soils.

3. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of the excavation faces being supported and damage to the work and adjacent property.
4. Do not leave any sheeting or bracing in the trench or excavation after completion of the work, unless approved or instructed by the Engineer. The cost of removing sheeting or bracing shall be at the Contractor's expense.
5. All sheeting and shoring in contact with concrete or masonry shall remain in place. The sheeting and shoring above the structure may remain or be cut off. No sheeting or shoring left in place shall be within three feet below the ground surface.

D. Obstructions:

1. Remove and dispose of all trees, stumps, roots, boulders, pavement, pipes and the like, as required for the performance of the work.
2. Exercise care in excavating around catch basins, inlets, manholes, piping, duct banks, underground vaults, etc.
3. Avoid removing or loosening castings or pushing dirt into structures.
4. Damaged or displaced castings shall be repaired and replaced, and dirt entering the structures during the performance of the work shall be removed at no additional cost to the 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:

In case 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.
   Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement.
   NOTE: No additional payment will be made for removing and replacing damaged adjacent pavement.
5. Remove and replace sidewalks disturbed by construction for their full width and to the nearest undisturbed joint.
6. 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, to insure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures 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.

3.02 EXCAVATION

A. Method:

1. All excavation shall be by open cut from the surface except as indicated on the Drawings.
2. All excavations for appurtenances and structures shall be made in such manner and to such depth and width as will give ample room for building the structures and for bracing, sheeting, and supporting the sides of the excavation, for pumping and draining groundwater and wastewater which may be encountered, and for the removal from the trench of all materials excavated.
3. Water shall not be allowed to accumulate in excavations. Contractor shall provide sufficient temporary pumping to assure that surface and ground waters do not saturate foundation soils.
4. Take special care so that soil below the bottom of the structure to be built is left undisturbed.

B. Grades:

1. Excavate to lines and grades indicated on the Drawings.
2. Where excavation grades are not indicated on the Drawings, excavate as required to accommodate installation.

C. Disposal of Excavated Material:

1. Remove and legally dispose of all excavated material not needed to complete filling, backfilling, and grading.
2. Dispose of excess excavated material at locations secured by the Contractor and in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or on any street or alley. No debris shall be deposited on any private property except by written consent of the property owner. In no case shall any material be left on the Project site, or be buried in embankments or trenches on the Project site. 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 problem. Excavated material shall be placed so as to not damage existing landscape or man-made improvements. Surcharging of any bank is not allowed.

D. Rock Excavation:

1. Rock excavation shall mean rock requiring drilling and blasting that occupies an original volume of at least one (1) cubic yard. Rock shall be considered as

material which cannot be removed with a crawler tractor equal to a D-8 Caterpillar, equipped with a single-tooth ripper or by an excavator trackhoe equal to a Caterpillar 225 rated with a ¾ cubic yard capacity with a bucket curling pullout capacity of 25,000 pounds.

2. Where rock is encountered within excavation for structures, it shall be excavated to the lines and grades indicated on the Drawings or as otherwise directed by the Engineer. The Contractor shall be responsible for obtaining any blasting permits required.
3. If excess excavation is made or the material becomes disturbed so as to require removal below final subgrade elevations or beyond the prescribed limits, the resulting space shall be refilled with Class B concrete in accordance with Section 03300, Cast-in-Place Concrete.

3.03 EXCAVATING FOR STRUCTURES

A. Excavation:

1. All excavation is unclassified and shall be included in the Contractor's Base Bid.
2. Excavation shall include all substances to be excavated. Excavation for structures shall be to limits not less than 2 feet outside wall lines, to allow for formwork and inspection.
3. Where rock excavation is carried below grade the Contractor shall backfill to grade using concrete or structural fill.
4. Where unsuitable material is encountered excavate material to a depth acceptable to the Engineer and fill with compacted structural fill as required.

B. Excavation for Foundations: Footings and slabs on grades shall rest on undisturbed earth, rock or compacted materials to insure proper bearing.

1. Unsuitable Foundation Material
   a. Any material in the opinion of the Engineer which is unsuitable for foundation shall be removed and replaced with coarse aggregate or structural fill material as directed by the Engineer.
   b. No determination of unsuitability will be made until all requirements for dewatering are satisfactorily met.
2. Foundation in Rock: Foundations for a structure shall be on similar materials. Should excavation for a foundation be partially in rock, the Contractor shall undercut that portion of the rock 12-inches and bring the excavation to grade with compacted crushed stone.

C. Construction Observations:

All excavations should be examined by the Engineer prior to reinforcing steel placement to verify that the design bearing pressure is available. All excavations should be clean, level and free of ponded water, mud and loose, frozen or water-softened soils. If it is necessary for an excavation to remain open overnight, or if rain is imminent, a 3-to 4-inch thick "mud mat" of Class B concrete may be placed in the bottom of the excavation to protect the bearing soils until reinforcing steel and concrete can be placed.

D. Unsuitable Bearing:

If unsuitable bearing for foundations is encountered at the elevations indicated on the Drawings, the Engineer shall be notified immediately.

3.04 EXCAVATION BELOW GRADE AND REFILL

If the bottom of any excavation is taken out below the limits shown on the Drawings or specified, it shall be refilled to the bottom grade, at the Contractor's expense, except where rock or unsuitable soil is encountered. The refill shall be 6-inch layers of structural fill or other material satisfactory to the Engineer. The type of material to be used shall be the Engineer's option.

3.05 BACKFILL AND FILL PLACEMENT

A. Compaction of fill shall be accomplished by placing the fill material in horizontal lifts of 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 a +/- 3% of the optimum moisture content, as determined by the standard Proctor moisture-density relationship test.

G. Compaction:

1. The fill shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil.
2. The upper twelve-inches (12") of fill beneath the structures and pavement areas shall be compacted to 98% of the standard Proctor maximum dry density.
3. Scarification and recompacting of the upper fill soils immediately prior to the slab-on-grade and/or pavement construction shall be required.
4. Compaction of embankments shall be by sheepsfoot rollers with staggered uniformly spaced knobs and suitable cleaning devices. The projected area of each knob and the number and spacing of the knobs shall be such that the total weight of the roller and ballast when distributed over the area of one (1) row of knobs shall be 250 psi. Placement and compaction of materials shall extend beyond the final contours sufficiently to insure compaction of the material at the resulting final surface. Final contours shall then be achieved by a tracked bulldozer or grader shaping the face of the embankment.
5. The backfill placement in trenches and behind structures shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil. In confined areas requiring portable compaction equipment the fill material shall be placed in horizontal lifts of four-inches (4") maximum loose thickness.
6. If tests indicate that density of backfill fill is less than that specified, the area shall be either be recompacted or undercut, filled, and compacted until specified density is achieved.

H. Final Grading: Upon completion of construction operations, the area shall be graded to finish contour elevations and grades shown on the Drawings. Graded areas shall be made to blend with remaining ground surfaces. All surfaces shall be left smooth and free to drain.

I. Moisture:

1. If fill material is too wet, provide and operate approved means to assist the drying of the fill until suitable for compaction.
2. If fill material is too dry, provide and operate approved means to add moisture to the fill layers.

J. Proofrolling:

1. All areas where pavement or structures are to be built on compacted fill and other areas where indicated on the Drawing, shall be proofrolled to detect soft spots prior to the placement of fill material or construction of foundations.
2. Proofrolling shall consist of the moving a 20-30 ton loaded dump truck or pneumatic tire roller over the subgrade after the subgrade is shaped. Proofrolling shall be witnessed by the Engineer.
3. Pneumatic-tired rollers shall have not fewer than four pneumatic tired wheels which shall be of such size and ply that tire pressures can be maintained between 80 and 100 pounds per square inch for 25,000 pound wheel load during rolling operations. Unless otherwise required, rolling shall be done with tires inflated to 90 psi. The roller wheels shall be located abreast in a rigid steel frame. Each wheel shall be loaded with an individual weight box so that each wheel will bear an equal load when traversing uneven ground. The weight boxes shall be suitable for ballast loading such that the load per wheel shall be 25,000 pounds. The spacing of the wheels shall insure that the distance between the nearest edges of adjacent tires shall be not greater than one-half of the tire width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller shall be operated not faster than 5 feet/second.
4. Subgrade shall be proofrolled with 6 passes. Depressions that develop during the proofrolling operation shall be filled with suitable material and those filled areas shall be proofrolled with 6 passes. If, after having been filled and proofrolled, the subgrade still contains depressions, the soil shall be undercut to the full depth of the soft material or 5 feet whichever is less, backfilled, and rolled to achieve a compacted subgrade.
5. After the proofrolled subgrade has been accepted by the Engineer, the surface of the subgrade shall be finish rolled with a smooth steel wheel roller weighing not less than 10 tons. Finished surface of the subgrade shall be within a tolerance of 0.04 feet at every point.
6. Conduits, pipes, culverts and underdrains shall be neither disturbed nor damaged by proofrolling operations. Rollers shall neither pass over, nor approach closer than 5 feet to conduits, pipes, culverts and underdrains unless the tops of those facilities are deeper than 3 feet.

K. During wet or rainy periods, aeration (drying) shall be required to reduce the fill materials to the required moisture condition. During dry periods, water shall be added to achieve the proper moisture content for compaction. Silty soils, which are wet, shall require aeration prior to compaction even during dry periods.

3.06 BACKFILLING AROUND STRUCTURES

A. General:

1. Remove debris from excavations before backfilling.
2. Do not backfill against foundation walls until so instructed by the Engineer

3. Wherever possible, backfilling shall be simultaneous on both sides of walls to equalize lateral pressures.
4. Do not backfill on only one (1) side of vertically spanning walls unless walls are adequately shored or permanent construction is in place to furnish lateral support on both top and bottom of wall.

3.07 GRADING

A. General:

1. Perform all rough and finish grading required to attain the elevations indicated on the Drawings.
2. Perform rough grading to an accuracy of plus or minus 0.10 feet.

B. Grading Around Buildings: Control the grading around buildings so the ground is pitched to prevent water from running into the excavated areas of a building or damaging other site features.

C. Treatment After Completion of Grading:

1. After grading is completed, permit no further excavation, filling or grading, except with the approval of the Engineer.
2. Use all means necessary to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.08 EXCESS WATER CONTROL

A. Unfavorable Weather:

1. Do not place, spread or roll any fill material during unfavorable weather conditions.
2. Do not resume operations until moisture content and fill density are satisfactory to the Engineer.
3. Any inundated area that freezes shall be removed and refilled at the Contractor’s expense.

B. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collected in depressions.

C. Pumping, Drainage and Dewatering:

1. Provide, maintain and use at all times during construction adequate means and devices to promptly remove and dispose of all water from every source entering the excavations or other parts of the Work.

2. Dewater by means, which will insure dry excavations, preserve final lines and grades, and do not disturb or displace adjacent soil.
3. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the work of other contractors, and in accordance with all pertinent laws, ordinances, and regulations.
4. Do not overload or obstruct existing drainage facilities.

3.09 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments, which may occur within one (1) year after final acceptance of the Work by the City.

B. The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after receipt of written notice from the Engineer.

3.10 CLEANING

Upon completion of the work of this Section, remove all rubbish, trash and debris resulting from construction operations. Remove surplus equipment and tools. Leave the site in a neat and orderly condition acceptable to the Engineer, and in conformance with the General Conditions of the Contract Documents.

+++END OF SECTION 02200+++

SECTION 02535
GRAVITY FLOW SANITARY SEWERS

PART 1 - GENERAL

1.01 SCOPE

A. The work covered under this section includes furnishing all labor, equipment, and materials required to furnish, install, test, and inspect gravity flow sanitary sewers as shown on the Plans and specified in this section.

B. Unless directed otherwise in writing by the Engineer, the Contractor shall use only the pipe sizes and materials specifically designated on the Plans.

C. Related Work Specified Elsewhere:

1. Section 01200 - Measurement and Payment
2. Section 02140 - Dewatering
3. Section 02200 - Earthwork
4. Section 02537 - Ductile Iron Sanitary Sewer Pipe and Fittings
5. Section 02538 - Sanitary Sewer Service Lateral Reconnection and Repairs
6. Section 02933 - Seeding
7. Section 03300 - Cast-In-Place Concrete

1.02 SUBMITTALS

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

1. The Contractor shall submit proposed methods, equipment, materials, and sequence of operations for sewer construction. The Contractor shall plan operations to minimize disruption of utilities and to occupied facilities on adjacent property.
2. The Contractor shall submit manufacturers' instructions indicating special procedures required to install products specified.
3. The Contractor shall submit certifications that products meet or exceed the requirements specified in these Specifications.
4. The Contractor shall submit a set of plans (modified to show as-built conditions.)
5. The Contractor shall submit test reports.

1.03 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

1. AASHTO T180 - Standard Specification For Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457-mm (180-in) Drop.
2. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
3. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
5. ASTM C700 – Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
6. ASTM D1557 - Standard Test Method for Laboratory, Compaction Characteristics of Soils Using Modified Proctor Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)
7. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
9. American Water Works Association (AWWA), Latest Revisions.

B. The Contractor shall provide the Engineer with the product manufacturers' written certification that all products furnished comply with all applicable provisions of these Specifications. Except as may be modified herein, all materials used in the manufacture of pipe, linings, manholes, and castings shall be new and shall be tested in accordance with the referenced standards, as applicable. 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.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall inspect pipe materials and fittings upon arrival at the site of the Work.

B. The Contractor shall handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear, or free fall. The Contractor shall not drag pipe and fittings along the ground. The Contractor shall not roll pipe unrestrained from delivery trucks.

C. The Contractor shall use mechanical means to move or handle pipe. The Contractor shall employ acceptable clamps, rope, or slings around the outside barrel of pipe and fittings.

PART 2 - PRODUCTS

2.01 PIPE MATERIALS

A. All materials used in the construction of gravity flow sanitary sewers shall be new, unused, and shall be of the sizes indicated on the Plans.

B. All materials shall be in strict compliance with the required standards and specifications including ASTM, ANSI, and AWWA.

C. At points of the sewer where a change in pipe classification is shown on the Plans, the Contractor may begin at the next joint of pipe rather than cutting the pipe and constructing a collar unless there is a change in horizontal or vertical alignment. In the event the pipe is cut, there shall be no torch cutting, only saw cutting will be allowed.

D. Ductile Iron Pipe and fittings shall conform to the requirements of Section 02537, Ductile Iron Sanitary Sewer Pipe and Fittings.

E. Polyvinyl Chloride Gravity Sewer Pipe shall conform to the requirements Section 02545, Polyvinyl Chloride Gravity Sewer Pipe

2.02 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.

2.03 APPURTENANCES

Service connections shall conform to the requirements of Section 02538, Sewer Service Connection Removal and Replacement.

2.04 BACKFILL

A. Pipe backfill materials shall conform to the requirements of Section 02200, Earthwork.

B. Topsoil shall conform to the requirements of Section 02933, Seeding.

PART 3 - EXECUTION

3.01 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.

3.02 PIPE LAYING

A. The Contractor shall install the pipe in accordance with the pipe manufacturer's recommendations and as specified in this section.

B. The Contractor is responsible for accurately placing pipe to the exact line and grade shown on the Plans. The control of vertical and horizontal alignments shall be accomplished by the use of a laser beam instrument. When a laser is used, the elevation and alignment of the pipe shall be checked by transit and level rod every fifty (50) feet for smaller pipe and every joint for pipe forty eight (48) inches and larger. Other approved methods of controlling vertical and horizontal alignments may be used if specifically authorized by the Engineer. The pipe section may be adjusted by the use of "come-along" of approved design and anchorage. The practice of bumping or snatching (with backhoe or crane, etc.) used to adjust pipe after placement in the trench, will not be permitted. The Contractor shall furnish all labor and materials necessary for controlling the line and grade.

C. Each piece of pipe and special fitting shall be carefully inspected before it is placed, and no defective pipe shall be laid in the trench. Before a sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill. Trench bottoms found to be unsuitable for foundations shall be undercut and brought to exact line and grade with pipe cushion, concrete cradles, foundation backfill, or as directed by the Engineer.

D. For bell and spigot pipe, bell holes shall be of sufficient size to allow ample room for properly making the pipe joints. Bell holes shall be cut no more than five (5) joints ahead of pipe laying. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and so as to avoid sudden offsets or inequalities in the flow line.

E. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. The Contractor shall not open up at 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.

3.03 JOINT CONSTRUCTION

A. For bell and spigot pipe, the inside of all bells and the outside of all spigots shall be wiped to remove all dirt, water, or other foreign matter so that their surfaces are clean and dry when the pipes are joined.

B. Rubber ring gasket joints for sewer pipe shall be installed according to the pipe manufacturer’s specifications and recommendations. Extreme care shall be used in joining large diameter pipe to avoid damaging the rubber ring or displacing it from the proper operating position.

C. Joints on ductile iron pipe sewers shall be compression joints, except where mechanical or flanged joints are called for on the Plans, and shall be installed according to the pipe manufacturers' specifications and recommendations.

D. After the joints have been completed, they shall be inspected by the Engineer before they are covered. Any leaks or defects discovered at 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.

3.04 TEE CONNECTIONS

A. Tee branches shall be installed in sanitary sewer lines at all points shown on the Plans or directed by the Engineer. If such branches are not to be used immediately, they shall be closed with approved stoppers and shall be physically restrained.

B. All existing sanitary service lines shall be disconnected from the existing combined sewer and reconnected to the new sanitary sewer.

C. Tees shall be installed in sanitary sewers so as to properly connect each existing house and to serve each vacant lot facing or abutting on the street or alley in which the sewer is being laid and at such other locations as may be designated by the Engineer. The exact location of each connection shall be recorded by the Contractor, on the record drawings, utilizing conventional GPS survey, before backfilling and said records delivered to the Engineer.

D. Tees shall be standard manufactured tees.

3.05 CONNECTING RISERS

A. Where shown on the Plans, included in the Special Conditions, or directed by the Engineer, and where the depth of cut is over eight (8) feet or where the grade of a sanitary sewer is lower than necessary to drain abutting property, and at such other locations as may be designated by the Engineer, connecting risers shall be installed to connect each existing house and to serve each vacant lot facing or abutting on the street on which the sewer is being laid.

B. Connecting risers shall be sized in accordance with the plumbing code in effect at the time of construction but shall not be smaller in size than shown on the Plans. Risers shall be installed from a tee connection to the elevation needed to connect house services, the elevations shown on the Plans, or as directed by the Engineer. The tee connection shall be installed at the location shown on the Plans, and in accordance with the Detail Drawings. Open ends of connecting risers shall be closed with approved stoppers and be physically restrained. Backfilling shall be carefully done around risers using materials specified in Section 02315 - Excavation and Backfill for Structures, and compacted to the equivalent density of the surrounding undisturbed material.

3.06 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 Section 02200, Earthwork, and shall be compacted to the equivalent density of the surrounding undisturbed material.

3.07 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.

3.08 TOLERANCES

Invert Elevations: The invert elevations shown on the Plans shall be field verified by the Contractor prior to construction. Prior to setting the laser or other vertical alignment control system for the sewer upstream of the manhole, the Contractor shall verify the elevation of the sewer installed at the manhole. Should the elevation differ from that shown on the Plans, the Contractor shall take the following corrective action:

1. If the sewer is laid at negative grade, the Contractor shall remove and reinstall the sewer at the correct grade at no additional cost to the City.
2. If the sewer is laid at a grade less than that shown on the Plans, thus reducing the sewer's capacity, the City may require the sewer to be removed and relaid at the correct grade at no additional cost to the City. As a minimum, the grade to the next upstream manhole shall be adjusted such that the next upstream manhole shall be set at the correct elevation.

3. If the sewer is laid at a grade greater than that shown on the City, and if the Contractor can show that there are no conflicts with upstream existing utilities or obstructions, the Contractor shall adjust the grade of the next upstream manhole such that the next upstream manhole shall be set at the correct elevation. If such an adjustment, in the Engineer's opinion, is substantial, the grade adjustment shall be spread over multiple sections of the sewer. If such an adjustment, in the City's opinion, significantly reduces the sewer's capacity, the City may require the Contractor to remove and relay that portion of the sewer laid at the improper grade.

3.09 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 as specified. 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 Section 02920, Site Restoration.

B. Prior to requesting a final inspection, the Contractor shall remove and dispose of all shipping timbers, shipping bands, boxes, and other like debris brought to the site of the Work.

C. Any lawns, fences, drainage culverts, or property damaged by the sewer construction shall be repaired or replaced to equal or better condition than existing prior to commencement of the Work.

D. All shoulders, ditches, culverts, and other areas affected by the sewer construction shall be at the proper grades and smooth in appearance to provide positive drainage of the site of the Work.

E. All manhole covers shall be brought to grade, as shown on the Plans, or as directed by the Engineer.

+++END OF SECTION 02535+++

SECTION 02537
DUCTILE IRON SANITARY SEWER PIPE AND FITTINGS

PART 1 - GENERAL

1.01 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 02140 - Dewatering
3. Section 02200 - Earthwork
4. Section 02535 - Gravity Flow Sanitary Sewers
5. Section 02538 - Sewer Service Connection Removal and Replacement

1.02 SUBMITTALS

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

1. 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.
2. 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.

3. The Contractor shall provide certifications that all pipe joints have been tested and meet the requirements of ANSI A21.11 (AWWA C151).

1.03 QUALITY ASSURANCE

A. Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

1. ANSI A21.4 (AWWA C104) - Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings, for Water and Other Liquids.
2. ANSI A21.10 (AWWA C110) - Ductile Iron and Gray Iron Fittings, 3-in. through 48-in., for Water and Other Liquids.
3. ANSI A21.11 (AWWA C111) - Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
4. ANSI A21.15 (AWWA C115) - Flanged Ductile Iron Pipe with Threaded Flanges.
5. ANSI A21.50 (AWWA C150) - Thickness Design of Ductile Iron Pipe.
6. ANSI A21.51 (AWWA C151) - Ductile Iron Pipe, Centrifugally Cast for Water and Other Liquids.
7. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
8. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
9. ASTM D1248 - Polyethylene Plastics Molding and Extrusion Materials.
10. ASTM G62 - Test Methods for Holiday Detection in Pipeline Coatings.
11. AWWA C600 - Standard for Installation of Ductile Iron Water Mains and Their Appurtenances.
12. SSPC-SP6 - Steel Structures Painting Council, Commercial Blast Cleaning.
13. 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.

1.04 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

2.01 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 push-on type such as Fastite, Tyton, or Super Bell-Tite or approved equal unless mechanical joints are specified elsewhere in these Specifications or approved by the Engineer. Joints shall be manufactured in accordance with the requirements of ANSI A21.11 (AWWA C111).

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.

2.02 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.

2.03 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

3.01 DUCTILE IRON PIPE

A. The Contractor shall conform to the installation requirements of Section 02535, Gravity Flow Sanitary Sewers, and Section 02538, Sewer Service Connection Removal and Replacement.

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

3.02 FITTINGS

The Contractor shall install fittings in accordance with applicable ANSI/AWWA standards and manufacturers' recommendations.

3.03 TESTING

Following the installation of ductile iron pipe, the Contractor shall air test all sewer pipe joints as specified. Joints failing the air test are subject to rejection, repair, or replacement at the Contractor’s expense.

+++END OF SECTION 02537+++

SECTION 02538
SEWER SERVICE CONNECTION REMOVAL AND REPLACEMENT

PART 1 GENERAL

1.01 SCOPE

The work covered under this section includes disconnecting and removing existing service connections from existing main line sanitary sewers that are to be abandoned and furnishing and installing new service connections to new main line sanitary sewers, all as shown on the Drawings and as specified herein and as directed by the Engineer.

1.02 SUBMITTALS

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

1. Product data for each pipe product, fitting, coupling and adapter.
2. A complete list of sewer service connections including footage and diameter of each sewer service connection along with station of new main line sewer service connection point shall be submitted to the Engineer prior to removal of sewer service connections from the existing sewer line.
3. Work plans detailing sewer service connection, reconnection and repair methods.
4. Record drawings showing location of reconnected sewer service connections.

1.03 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions to the following standards, except as otherwise shown on the Drawings or specified herein.

1. ANSI/AWWA C111/ A21.11 - Rubber Gaskets Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings
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 C425 – Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
5. ASTM C700 - Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
6. ASTM C1173 – Standard Specification for Flexible Transition Couplings for Underground Piping Systems
7. ASTM D1784 - Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
8. ASTM D1785 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe,

Schedule 40, 80, and 120

9. ASTM D3034 - Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
10. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe and fittings for sewer service connections shall be as specified in Section 02537, Ductile Iron Sanitary Sewer Pipe.

B. Non-shrink grout shall be as specified in Section 03600, Grout.

C. Flexible Couplings

1. Sleeve type flexible couplings shall be used to connect pipes of different materials.
2. Couplings shall consist of:
   a. SBR synthetic rubber collar
   b. Corrosion resistant shear ring
   c. Stainless steel clamps with worm drive or take-up bolts
3. Couplings shall conform to ASTM C1173 and shall be manufactured by Fernco Inc., Mission Rubber Company or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor's attention is directed to the fact that underground sewer service connections are not shown on the Drawings.

B. The Contractor shall not allow sand, debris, or runoff to enter the sewer system.

C. The Contractor shall ensure that wastewater does not backup onto private property. The Contractor shall establish a plan to prevent sewer backups when reconnections are not accomplished in a timely manner.

D. The Contractor shall be responsible for all damage to property due to his work. Any damage caused to private property shall be corrected or repaired to the satisfaction of the property owner at the Contractor's expense.

E. The Contractor shall remove and replace service connections, including those that go to unoccupied or abandoned buildings, unless directed otherwise by the Engineer.

F. Service connections shall be terminated at the edge of the existing right-of-way or easement or connected to existing service connection pipe as necessary and as directed by the Engineer.

3.02 PREPARATION

A. The Contractor shall control traffic in accordance with the requirements of Section 01550, Traffic Regulation.

B. The Contractor shall coordinate with the City for any interruption of sanitary sewer service to the pump station.

C. All existing, new and proposed sewer service connections shall be identified prior to pipe installation or replacement.

3.03 REMOVAL OF EXISTING SEWER SERVICE CONNECTIONS

A. Existing sewer service connection pipe shall be removed or abandoned as necessary to allow for new sewer service connection installation.

B. The vertical alignment of a new main line sewer may either be above, below or at the same elevation as the existing main line sewer as shown on the profiles on the Drawings. After exposing the existing sewer service connection, the Contractor shall remove the existing sewer service connection and furnish and install a new service connection to the new main line sewer as specified herein and as shown on the Drawings.

C. Pipe removed shall be immediately removed from the work site by the Contractor. Pipe shall not be removed until sufficient replacement pipe is on site and available for installation.

D. The Contractor shall plug the open ends of all abandoned sewer service lines using concrete conforming to the requirements of Section 03300, Cast-In-Place Concrete.

3.04 CONNECTIONS TO NEW SANITARY SEWER

. A. The Contractor shall install wyes or tees in locations shown on the Drawings or as designated by the Engineer for future connection of service connections or connection to live existing services. The Contractor shall plug the branch of the wye or tee until service connections are installed. The Contractor shall record the location of fittings installed on the Record Drawings.

B. The Contractor shall make up the connection between the new main line sewer and the existing service connection using the same diameter pipe as currently connected to the sewer unless directed otherwise by the Engineer. Minimum pipe diameter shall be 6-inches.

C. Connection of sewer service lines or risers to new sewer main lines less than or equal to 12-inches in diameter shall be by means of standard tees or wyes as shown on the Drawings. The Contractor shall make up the connection between the new main and the existing service line using sewer pipe and fittings conforming to the requirements of paragraph 2.01 of this Section as follows:

1. All service connections shall be made by removing a portion of the main line sewer and installing a wye or tee for connecting the sewer service on the main line sewer.
2. The wye or tee shall be coupled to the existing main line sewer with couplings as specified in paragraph 2.01 of this section.

D. The Contractor's attention is directed to the standard details on the Drawings which show alternate methods of making service connections to main line sewers larger than 12-inches in diameter.

E. Service connections shall be made at the top or from the side at forty-five (45) degrees of the sewer line as shown on the Drawings or as directed by the Engineer.

F. In the event a lined pipe is encountered, the host pipe (outer) pipe material shall be used to determine the service line pipe material.

3.05 INSTALLATION OF SERVICE CONNECTIONS

A. Minimum slope for service connection shall be two percent (2%), unless the existing service connection is at a lower slope, in which instance the Contractor shall lay the service connection at the existing slope. Installation of service lines shall comply with the requirements of Section 02200, Earthwork.

B. Sewer service connections from main line sewers will be extended on a straight uniform grade from the main point to the terminus. Sewer service connections shall not exceed a depth of twelve (12) feet below finished grade at the end of the connection at the right-of-way or easement line unless specifically approved by the Engineer.

C. Sewer service connections to be extended from main line sewers where the property being served does not require the full depth, may be brought up to grade with a riser pipe as shown on the profiles on the Drawings. Riser pipe shall be installed in accordance with the details shown on the Drawings.

D. Sewer Service Connections Crossing Pavement

Service connections may be installed by open trench if permitted by the City, Fulton County or the Georgia Department of Transportation, where applicable based on the location of the Work. Installation of service connections by the open trench method shall meet the requirements of Section 02200, Earthwork.

E. If the service connection ends in rock, the Contractor shall excavate the rock an

additional three (3) feet beyond the plugged end.

F. All sewer service connections shall be provided with a cleanout at the easement or right-of-way line. Cleanouts shall be installed as shown on the Drawings.

G. The Contractor shall test new service lines before backfilling.

3.06 UTILITY SERVICE REPAIRS

Where utility service connections to the user's premises are disconnected, broken, damaged, or otherwise rendered inoperable by the Contractor for any reason, the Contractor shall, at its own expense, arrange with the respective utility company for any repairs of lines under their jurisdiction, or for any lines not within their jurisdiction or the Contractor shall repair or replace same and restore service to the premises.

3.07 TESTING

A. Following completion of sanitary sewer installation and reconnection of service lines, the Contractor shall perform CCTV, smoke testing or other testing method approved by the Engineer to confirm that all service connections are reconnected.

B. Before backfilling, couplings shall be pressure tested to 4.3 psi.

D. If any joint shows leakage, the jointing material shall be removed and the joint remade If any pipe is defective, it shall be removed and replaced.

3.08 CLEANUP

A. The Contractor shall replace pavements, curbs and gutters, driveways, or sidewalks removed or damaged by excavation in accordance with the requirements of the applicable sections of these specifications and the standard details shown on the Drawings.

B. In unpaved areas, the Contractor shall bring the surface to grade and slope surrounding the excavation. The Contractor shall replace a minimum of four (4) inches of topsoil and seed according to the requirements of Section 02933, Seeding.

+ + + END OF SECTION 02538 + + +

SECTION 02545
POLYVINYL CHLORIDE GRAVITY SEWER PIPE

PART 1 - GENERAL

1.01 SCOPE

A. This section includes Specifications for polyvinyl chloride gravity sewer pipe for sanitary sewer installations as shown on the Plans and as specified in these Specifications.

B. The Contractor shall provide all services, labor, materials, and equipment required for all polyvinyl chloride gravity sewer pipe installation and acceptance testing and related operations necessary or convenient to the Contractor for furnishing a complete Work as shown on the Plans or specified in these Specifications.

C. Related Work Specified Elsewhere;

1. Section 01200 - Measurement and Payment
2. Section 02000 - Site Work
3. Section 02140 - Dewatering
4. Section 02200 - Earthwork
5. Section 02538 - Sewer Service Connection Removal and Replacement

1.02 SUBMITTALS

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

1. Product Data: The Contractor shall submit, for the Engineers approval, descriptive details and shop drawings covering full details of pipe, fittings, specials, joints and assembly thereof, joint materials and details thereof, and full details and cuts of all castings to be incorporated into the Work.
2. Manufacturer’s Installation Instructions: The Contractor shall submit special procedures required to install products specified.
3. Manufacture’s Certificate: The Contractor shall submit a manufacture’s certificate certifying that products meet or exceed the requirements of ASTM D3034, ASTM F1336, and the requirements of these Specifications.
4. Record Drawings: At project closeout, the Contractor shall submit record drawings of installed sewer piping and products.

1.03 QUALITY ASSURANCE

Reference Standards: The Contractor shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Plans or specified in these Specifications.

1. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
2. ASTM D3212a - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
3. ASTM F1336 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings.
4. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
5. ASTM D448 - Standard Sizes of Course Aggregate for Highway Construction.
6. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
7. ASTM F1417-92(1998) - Standard Test Method of Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

1.04 TESTING

Pipe joints, and fittings shall comply with the latest revisions of ASTM D3034, ASTM F1336, and be tested in accordance with the requirements of ASTM F1417.

1.05 ACCEPTANCE

A. Acceptance shall be on the basis of in-plant testing and inspection of manufactured pipe for visual defects and imperfections in accordance with the requirements of ASTM D3034 and ASTM F1336.

B. The Contractor shall provide manufacturers' results of testing on pipe, joint materials, and assemble joints as required by the City. These tests shall include material and hydrostatic leakage tests on pipe of each size in accordance with the requirements of ASTM D3034 and ASTM F1417.

C. The Contractor shall inspect the pipe after delivery for shape, cracks, uniformity, blisters and imperfect surfaces, damaged ends, and gasket grooves. The Contractor shall not use repaired or patched pipe or pipe with repaired or patched gasket grooves or shoulders. Imperfections in the barrel or socket of a pipe or fitting will be rejected.

PART 2 - PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC), FOR SEWER SERVICE LATERALS OUTSIDE RIGHT OF WAY

All polyvinyl chloride gravity sewer pipe shall be SDR 35 and conform to all requirements of ASTM D3034, ASTM F1336, and the Georgia Department of Natural Resources, "Guidelines for Gravity Sewers", dated March 29, 1996. Acceptance shall be on the basis of hydrostatic pressure testing as described in ASTM F1417.

2.02 JOINTS

Joints for PVC and Fittings shall conform to the requirements of ASTM D3212 using elastomeric gaskets conforming to ASTM F477.

2.03 FITTINGS AND SPECIALS

A. The Contractor shall provide fittings and specials to meet the Project requirements and in accordance with the requirements of ASTM F1336.

B. The Contractor shall provide service connections and associated fittings as required to reconnect existing service connections to the PVC. Connections shall be made by using factory made wyes or tees as directed by the Engineer.

2.04 PIPE MARKINGS

All pipe and fittings shall be clearly marked with the name or trademark of the manufacturer, the plant where the pipe was made, and the strength designation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall install PVC pipe in accordance with the requirements of ASTM D2321.

B. Excavation for the pipe and preparation of the trench bottom, including bedding to receive the pipe shall be done in accordance with the requirements of this section and Section 02200, Earthwork.

C. Trench backfilling shall be performed in accordance with the requirements of Section 02200, Earthwork and the Manufactures' recommendations.

D. Bedding for PVC pipe shall be Class B as shown on City of Atlanta Standard Detail G-2, or as required by the manufacturer.

E. Pipe bedding shall be placed on a flat undisturbed or restored trench bottom with a minimum thickness of four (4) inches beneath the pipe barrel or 1/8th of the outside diameter of the pipe, whichever is greater. For trenches cut in rock, the minimum bedding placed under the pipe shall be six (6) inches or 1/8th of the outside diameter of the pipe, whichever is greater. Pipe haunching materials shall be shovel-sliced in the haunch area of the pipe.

F. The pipe shall be placed true to line and grade. Bell holes shall be dug and the barrel of the pipe provided with uniform and continuous support.

G. Standard sizes for bedding materials shall be in accordance with the requirements of ASTM D448 and Section 02200, Earthwork.

3.02 ACCEPTANCE TESTING

A. After installation, backfilling, and cleaning, acceptance testing shall be performed by low pressure air testing as specified in Section 02535, Gravity Flow Sanitary Sewers.

B. Air Testing

1. Testing shall be performed by the low pressure air test method conforming to the requirements of ASTM F1417.
2. Each section between manholes or structures shall be plugged. Air will be introduced into the plugged system. The system passes the test if the air loss, as measured by the pressure drop from 3.5 psi to 2.5. psi, does not occur within the time interval found in ASTM F1417 or the NCPI pamphlet, " Low Pressure Air Test for Sanitary Sewers".
3. Lines which fail any acceptance testing shall be evaluated and the source of leakage corrected. The line shall then be retested for compliance with the requirements of these specifications.

+++ END OF SECTION 02545 +++

SECTION 02665
WATER MAINS AND ACCESSORIES

PART I GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment and incidentals required for the complete installation of water mains and accessories as shown on the Drawings and as specified herein. Work also includes the hydraulic testing and disinfection of the completed water mains after installation.

B. This Section includes ductile iron pipe and fittings ranging in size from 4-inches in diameter through 64-inches in diameter.

C. 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.

D. Galvanized pipe and fittings shall not be used as any part of the Water Transmission and Distribution System, nor shall it be used to join any appurtenances to the System.

1.02 QUALITY ASSURANCE

Reference Standards: The design, manufacturing and assembly of elements of the products herein specified shall comply with the applicable provisions and recommendations of the latest editions of the following standards, except as otherwise shown on the Drawings or otherwise specified.

1. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. ANSI/AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
3. ANSI/AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
4. ANSI/AWWA C115/A21.15 – Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
5. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile-Iron Pipe
6. ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast
7. ANSI/AWWA C153/A21.53 – Ductile-Iron Compact Fittings for Water Service
8. ANSI/AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
9. ANSI /AWS D11.2 – Guide for Welding Iron Castings

10. AWWA C651 – Disinfecting Water Mains

1.03 SUBMITTALS

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

1. Product data and engineering data, including shop drawings.
2. Evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two (2) years.
3. Written certification that all products furnished comply with all applicable requirements of these specifications.

B. For pipe 24-inches in diameter or greater, submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings, adapters, valves and specials along with the manufacturer's drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, pipe stationing for all changes in grade or horizontal alignment, transition stations for various pipe classes and the limits of each reach of restrained joint pipe. The above shall be submitted to the Engineer for review before fabrication and shipment of these items.

1.04 TRANSPORTATION AND HANDLING

A. Unloading: Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification. Pipe handled on skids shall not be rolled or skidded against the pipe on the ground.

B. Handling: Handle pipe, fittings, and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front end loader. Do not use material damaged in handling. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe.

1.05 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

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. Stored mechanical and push-on joint gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

E. Mechanical joint bolts shall be handled and stored in such a manner that will ensure proper use with respect to types and sizes.

1.06 WATER MAIN LOCATION

A. The minimum depth of cover over the pipe shall be four (4) feet and the maximum cover shall be five (5) feet. Any deviations must be approved by the Engineer.

B. The installation of the water main parallel to another utility in the same vertical plane is not permitted, i.e., “stacking of utilities is not permitted.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE

A. Ductile iron pipe shall be manufactured in accordance with ANSI/AWWA C151/A21.51. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings. All pipe shall have a minimum pressure rating as indicated in the following table and corresponding minimum wall thickness, unless otherwise specified or shown on the Drawings:

Pipe Sizes (inches)	Pressure Class (psi)
4 - 12	350
14 - 18	350
20	300
24	250
30 - 54	200
60 - 64	200

B. Flanged pipe minimum wall thickness shall be equal to Special Class 53. Flanges shall be furnished by the pipe manufacturer.

C. Fittings shall be ductile iron and shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 with a minimum rated working pressure of 250 psi.

D. 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 ANSI/AWWA C111/A21.11.
2. The only acceptable restrained joint systems are identified in the table below. No field welding of restrained joint pipe will be allowed.

Acceptable Restrained Joints				
Pipe Dia. (in.)	**ACIPCO**	**U.S. Pipe**	**McWane**	**Generic***
4 – 12	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
16 – 24	Fast-Grip Flex Ring	Field Lok TR Flex	Push-On Restrained Joint Type A	MJ with Retainer Gland
30 – 36	Flex Ring	TR Flex	Push-On Restrained Joint Type B	MJ with Retainer Gland
42 – 48	Flex-Ring	TR Flex	N/A	MJ with Retainer Gland
54 – 64	Lok-Ring	TR Flex	N/A	N/A

* Fittings and valves only, and only where specifically allowed.

3. Restrained joint pipe (RJP) on supports shall have bolted joints and shall be specifically designed for clear spans of at least 36 feet.
4. Flanged joints shall meet the requirements of ANSI B16.1, Class 125.

E. Gaskets: Gaskets for the various types of joints shall be as follows:

1. Gaskets for mechanical joints shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified

otherwise. Reclaimed or natural rubber shall not be used. Gaskets shall be free from porous areas, foreign material and other defects that make them unfit for the use intended.

2. Gaskets for flanged joints shall be made of synthetic rubber, ring type or full face type and shall be 1/8-inch thick. Gaskets shall conform to the dimensions specified in ANSI/AWWA C111/A21.11.
3. Gaskets for push-on and restrained joints shall be in accordance with the pipe manufacturer's design dimensions and tolerances. Gaskets shall be made of vulcanized styrene butadiene (SBR) as specified in ANSI/AWWA C111/A21.11 unless specified otherwise.

F. Bolts and Nuts

1. 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.
2. Bolts and nuts for mechanical joints shall be tee head bolts and nuts of high-strength low-alloy steel having a minimum yield strength of 45,000 psi. Dimensions of bolts and nuts shall be in accordance with the dimensions shown in ANSI/AWWA C111/ A21.11.
3. 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.
4. Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A563. Zinc plating shall conform to ASTM B633, Type II.
5. Bolts for submerged service shall be stainless steel machine bolts conforming to ASTM A193, Grade B8. Nuts shall be heavy hex, stainless steel conforming to ASTM A194, Grade 8.

G. Mechanical joint glands shall be ductile iron.

H. Welded Outlets: Welded outlets may be provided in lieu of tees or saddles on mains with a diameter greater than or equal to 24-inches. The pipe joint on the outlet pipe shall meet the joint requirements specified above. The minimum pipe wall thickness of the parent pipe and the outlet pipe shall be Special Thickness Class 53 (Pressure Class 350 for 60 and 64-inch sizes). The welded outlet shall be rated for 250 psi working pressure. Each welded outlet shall be hydrostatically tested at 500 psi. The welded outlet shall be fabricated by the manufacturer of the parent pipe. The maximum outlet diameters shall not exceed those listed in the table below:

Parent Pipe Diameter, Inches	Maximum Outlet Diameter, Inches
24	16
30	20
36	24
42	30
48	30
54	30
60	30
64	30

I. Thrust collars shall be welded-on ductile iron body type designed to withstand thrust due to 250 psi internal pressure on a dead end from either direction on that pipe size. The thrust collars shall be continuously welded to the pipe by the pipe manufacturer.

J. Solid sleeves shall be used to connect plain end ductile iron pipe. Solid sleeves shall meet the requirements of ANSI/AWWA C110/A21.10 for long pattern and have a minimum pressure rating of 250 psi. Solid sleeves shall have mechanical or restrained joints as specified in this section or as shown on the Drawings. Solid sleeves shall be used only in locations shown on the Drawings or at the discretion of the Engineer. Solid sleeves shall be manufactured by American Cast Iron Pipe Company or U. S. Pipe.

K. Pipe stubs for all structure connections shall not exceed 2-feet in length. Caps shall be furnished where required.

M. Cement Lining

1. Interior surfaces of all ductile iron pipe and fittings shall be cleaned and lined with a cement mortar lining applied in conformity with ANSI/AWWA C104/A21.4. If lining is damaged or found faulty upon delivery, the damaged pipe sections shall be repaired or removed from the site as directed by the Engineer.
2. Lining thickness: The minimum lining thickness shall be as shown in the following table. Lining shall be square and uniform with regard to the longitudinal axis of the pipe.

Pipe Diameter (Inches)	Minimum Lining Thickness (Inches)
3 - 12	1/8
14 - 24	3/32
30 - 64	1/8

N. Pipe Coating: Unless otherwise specified, pipe and fittings shall be coated with a 1 mil asphaltic coating as specified in ANSI/AWWA C151/A21.51.

O. Polyethylene Encasement: Ductile iron pipe shall be encased with polyethylene film where shown on the Drawings, specified or directed by the Engineer.

P. Pipe Insulation: Where a water main is exposed to the elements because the pipe is above ground, the Engineer shall determine whether the pipe is to be insulated or not. Where insulation is to be furnished and installed it shall conform to the following:

1. Insulating material shall be 3-inch thick polyurethane pipe covering formed to fit the pipe diameter.
2. Outer covering shall be 0.016-inch thick aluminum chiller jacket with moisture shield and secured with stainless steel wire or stainless steel straps.

Q. 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.

2.02 PIPING APPURTENANCES

A. Mechanical Joint Restraint

1. Design
   a. Restraint devices for pipe sizes 3 inches through 48 inches in diameter shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
   b. The devices shall have a working pressure rating of 350 psi for 3-16 inch diameter pipe and 250 psi for 18-48 inch diameter pipe. Ratings are for water pressure and shall include a minimum safety factor of 2 to 1 in all sizes.

2. Material
   a. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.
   b. Ductile iron gripping wedges shall be contoured to fit on the pipe and shall be heat treated within a range of 370 to 470 BHN.

c. Dimensions of the glands shall be such that they can be used with the standard mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA C111/A21.11 and ANSI/AWWA C 153/A21.53, latest editions.

3. Approvals
   a. Restraint devices shall be listed by Underwriters Laboratories (3-inch through 24-inch size) and approved by Factory Mutual (3-inch through 12-inch size).
   b. Mechanical joint restraint shall be Megalug Series 1100 as manufactured by EBAA Iron Inc., Uni-Flange Series 1400, as manufactured by Ford Meter Box Company or approved equal.

B. Hydrant Connections

1. Pipe: Pipe shall have mechanical joint ends and be as specified in paragraph 2.02 of this Section.
2. Hydrant Tees: Hydrant tees shall conform to ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Tapping saddles shall not be allowed.
3. Anchor Couplings:
   a. Anchor couplings for hydrant installation shall be class 350 ductile iron pipe meeting the requirements of AWWA C151/ANSI A21.51, Class 53 and shall have an anchoring feature at both ends so that when used with mechanical joint split glands a restrained joint is provided.
   b. Anchor couplings shall be cement lined in accordance with ANSI/AWWA C104/ A21.4 and shall have a bituminous coating in accordance with ANSI/AWWA C151/A21.51.
   c. Anchor couplings shall be equal to swivel anchor pipe and couplings as manufactured by Fab Pipe, Inc., Tyler Utilities Division of Union Foundry Company or approved equal.
4. Hydrant Connector Pipe:
   a. Hydrant connector pipe shall be class 350 ductile iron meeting the requirements of ANSI/AWWA C153/A21.53 and shall be offset design so that the hydrant can be adjusted to ensure placement at the proper grade. Connector pipe shall have an anchoring feature at both ends so that when used with mechanical joint split glands a restrained joint is provided.
   b. Hydrant connector pipe shall be cement lined in accordance with ANSI/AWWA C104/ A21.4 and have a bituminous coating in accordance with ANSI/AWWA C151/A21.51.
   c. Hydrant connector pipe shall be equal to the Gradelok as manufactured by Assured Flow Sales, Inc., Sarasota, Florida.
   d. Hydrant connector pipe shall not be used unless specifically directed by the Engineer.

C. Tapping Saddles: Tapping saddles are not allowed.

D. Detection Tape: Detection tape shall be composed of a solid aluminum foil encased in a protective plastic jacket. Tapes shall be color coded in accordance with APWA color codes with the following legends: Water Systems, Safety Precaution Blue, "Caution Water Line Buried Below". Colors may be solid or striped. Tape shall be permanently printed with no surface printing allowed. Tape width shall be a minimum of 2-inches when buried less than 10-inches below the surface. Tape width shall be a minimum of 3-inches when buried greater than 10-inches and less than 20-inches. Detection tape shall be equal to Lineguard Type III Detectable or Allen Systems Detectatape.

PART 3 EXECUTION

3.01 LAYING AND JOINTING PIPE AND ACCESSORIES

A. Lay all pipe and fittings to accurately conform to the lines and grades as shown on the Drawings or as established by the Engineer.

B. Pipe Installation

1. Proper equipment, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings, valves and hydrants shall be lowered carefully into the trench by means of slings, ropes or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.
2. All pipe, fittings, valves, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.
3. All lumps, blisters and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit or any foreign materials before the pipe is laid. No pipe containing dirt shall be laid.
4. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing or other materials shall be placed in the pipe at any time.
5. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.
6. It is not mandatory to lay pipe with the bells facing the direction in which work is progressing.
7. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade, shall not be permitted.
8. Provide detection tape for all pipe greater than 12-inches in diameter. Detection tape shall be buried 4 to 10-inches deep. Should detection tape need to be installed deeper, the Contractor shall provide 3-inch wide tape. In no case shall detection tape be buried greater than 20-inches from the finish grade surface.

C. Alignment and Gradient

1. Lay pipe straight in alignment and gradient or follow true curves as nearly as practicable. Do not deflect any joint more than the maximum deflection recommended by the manufacturer.
2. Maintain a transit, level and accessories at the work site to lay out angles and ensure that deflection allowances are not exceeded.

D. Expediting of Work: Excavate, lay the pipe, and backfill as closely together as possible. Do not leave unjointed pipe in the trench overnight. Backfill and compact the trench as soon as possible after laying and jointing is completed. Cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, close the end with a suitable plug, either push-on, mechanical joint, restrained joint or as approved by the Engineer.

E. Joint Assembly

1. Push-on, mechanical, flange and restrained type joints shall be assembled in accordance with the manufacturer's recommendations.
2. The Contractor shall inspect each pipe joint within 1,000 feet on either side of main line valves to insure 100 percent seating of the pipe spigot, except as noted otherwise.
3. Each restrained joint shall be inspected by the Contractor to ensure that it has been “homed” 100 percent.
4. The Contractor shall internally inspect each pipe joint to insure proper assembly for pipe 24-inches in diameter and larger after the pipe has been brought to final alignment.

F. Cutting Pipe: The Contractor shall cut the pipe and bevel the end, as necessary, to provide the correct length of pipe necessary for installing the fittings, valves, accessories and closure pieces in the correct location. Only push-on or mechanical joint pipe shall be cut. Cement lining shall be undamaged.

G. Polyethylene Encasement: Installation shall be in accordance with ANSI/AWWA C105/A21.5 and the manufacturer's instructions. All ends shall be securely closed with tape and all damaged areas shall be completely repaired to the satisfaction of the Engineer.

3.02 CONNECTIONS TO WATER MAINS

A. Make connections to existing pipe lines with tapping sleeves and valves, unless specifically shown otherwise on the Drawings.

B. Location: Before laying pipe, locate the points of connection to existing water

mains and uncover as necessary for the Engineer to confirm the nature of the connection to be made.

C. Interruption of Services: Make connections to existing water mains only when system operations permit and only when notices are issued to the customer. The Contractor will operate existing valves only with the specific authorization and direct supervision of the Owner.

D. Tapping Sleeves

1. Holes in the new pipe shall be machine cut, either in the field or at the factory. No torch cutting of holes shall be permitted.
2. Prior to attaching sleeve, the pipe shall be thoroughly cleaned utilizing a brush and rag as required.
3. Before performing field machine cut, the watertightness of the sleeve assembly shall be pressure tested. The interior of the assembly shall be filled with water. An air compressor shall be attached, which will induce a test pressure as specified in this Section. No leakage shall be permitted for a period of five minutes.
4. After attaching the sleeve to an existing main, but prior to making the tap, the interior of the assembly shall be disinfected. All surfaces to be exposed to potable water shall be swabbed or sprayed with a one percent hypochlorite solution.

E. Connections using Solid Sleeves: Where connections are shown on the Drawings using solid sleeves, the Contractor shall furnish materials and labor necessary to make the connection to the pipe line including cutting, excavation and backfill..

F. Connections Using Couplings: Where connections are shown on the Drawings using couplings, the Contractor shall furnish materials and labor necessary to make the connection to the existing pipe line, including all necessary cutting, excavation and backfill.

3.03 THRUST RESTRAINT

A. Provide restraint at all points where hydraulic thrust may develop.

B. Retainer Glands: Provide retainer glands where shown on the Drawings. Retainer glands shall be installed in accordance with the manufacturer's recommendations, particularly, the required torque of the set screws. The Contractor shall furnish a torque wrench to verify the torque on all set screws which do not have inherent torque indicators.

C. Harnessing

1. Provide harness rods only where specifically shown on the Drawings or

directed by the Engineer.

2. Harness rods shall be manufactured in accordance with ASTM A36 and shall have an allowable tensile stress of no less than 22,000 psi. Harness rods shall be hot dip galvanized or field coated with bitumastic before backfilling.
3. Where possible, harness rods shall be installed through the mechanical joint bolt holes. Where it is not possible, provide 90 degree bend eye bolts.
4. Eye bolts shall be of the same diameter as specified in ANSI/AWWA C111/A21.11 for that pipe size. The eye shall be welded closed. Where eye bolts are used in conjunction with harness rods, an appropriate size washer shall be utilized with a nut on each end of the harness rod. Eye bolts shall be of the same material and coating as the harness rods.

D. Thrust Collars: Collars shall be constructed as shown on the Drawings.

E. Concrete Blocking

1. Provide concrete blocking for all bends, tees, valves, and other points where thrust may develop, except where other exclusive means of thrust restraint are specifically shown on the Drawings.
2. Concrete shall be as specified in Section 03300, Cast-in-Place Concrete.
3. Form and pour concrete blocking at fittings as shown on the Drawings and as directed by the Engineer. Pour blocking against undisturbed earth. Increase dimensions when required by over excavation.

3.04 INSPECTION AND TESTING

A. All sections of the water main shall be hydrostatically pressure tested in accordance with AWWA C600 and these Specifications. A section of main will be considered ready for testing after completion of all thrust restraint and backfilling.

B. Water used for flushing and testing mains and other construction purposes will be made available to the Contractor as specified in Section 01040, Coordination.

C. Each segment of water main between main valves shall be tested individually.

D. Test Preparation

1. For water mains less than 24-inches in diameter, flush sections thoroughly at flow velocities, greater than 2.5 feet per second, adequate to remove debris from pipe and valve seats. For water mains 24-inches in diameter and larger, the main shall be carefully swept clean, and mopped if directed by the Engineer. Partially open valves to allow the water to flush the valve seat.
2. Partially operate valves and hydrants to clean out seats.
3. Provide temporary blocking, bulkheads, flanges and plugs as necessary, to

assure all new pipe, valves and appurtenances will be pressure tested.

4. Before applying test pressure, air shall be completely expelled from the pipeline and all appurtenances. Insert corporation cocks at high points to expel air as main is filled with water as necessary to supplement automatic air valves. Corporation stops shall be constructed with a meter box as shown on the Drawings.
5. Fill pipeline slowly with water. Provide a suitable pump with an accurate water meter to pump the line to the specified pressure.
6. The differential pressure across a valve or hydrant shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, provide temporary backpressure to meet the differential pressure restrictions.
7. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

E. Test Pressure: Test the pipeline at 250 psi measured at the lowest point for at least two hours. Maintain the test pressure within 5 psi of the specified test pressure for the test duration. Should the pressure drop more than 5 psi at any time during the test period, the pressure shall be restored to the specified test pressure. Provide an accurate pressure gauge with graduation not greater than 5 psi.

F. Testing Allowance

1. Testing allowance shall be defined as the sum of the maximum quantity of makeup water that must be added into the pipeline undergoing hydrostatic pressure testing, or any valved section, in order to maintain pressure within 5 psi of the specified test pressure for the test duration plus water required to return line to test pressure at the end of the test. Leakage shall be the total cumulative amount measured on a water meter.
2. The Owner assumes no responsibility for leakage occurring through existing valves.

G. Test Results: No installed pipe shall be accepted if the quantity of makeup water exceeds the limits determined by the following formula:

$$L = \frac{SD\,(P)^{1/2}}{148{,}000}$$

Where: L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

As determined under Section 5 of ANSI/AWWA C600.

H. If the water main section being tested contains lengths of various pipe diameters, the allowable leakage shall be the sum of the computed leakage for each diameter. The leakage test shall be repeated until the test section is accepted. All visible leaks shall be repaired regardless of leakage test results.

I. After a pipeline section has been accepted, relieve test pressure. Record type, size and location of all outlets on record drawings.

J. At the conclusion of the work, the contractor shall thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stone, pieces of wood or other material which may have entered the pipeline during the construction period.

K. The Contractor shall be responsible for legal disposal of all water used for flushing and testing.

3.05 ABANDONING/KILLING EXISTING WATER MAINS AND VALVES

A. General:

1. Abandon in place all existing water main segments and valves indicated on the Drawings to be abandoned or killed. Abandon existing water mains and valves after the new water main has been placed in service and all water main services have been transferred over to the new main.
2. The Contractor shall be responsible for uncovering and verifying the size and material of the existing main to be abandoned and cut and plugged.

B. Cutting and Plugging Main:

1. Disconnect existing main by sawing or cutting and removing a segment of existing pipe where cutting and capping or plugging is shown on the Drawings or as directed by the Engineer.
2. Provide a watertight pipe cap or plug and concrete blocking for restraint to seal off existing mains indicated to remain in service.
3. Seal ends of existing mains to be abandoned with a pipe cap or plug or a masonry plug and pour a minimum of 6-inches of concrete on all sides around the end of the pipe.

C. Valves:

1. Pavement shall be saw cut and removed from around valve box. The direction of the pavement cuts shall be parallel and perpendicular to the direction of the traffic. Size of saw cut shall be 18-inches x 18-inches (maximum).
2. Remove all valve covers, valve boxes and extension stems from valves on mains to be abandoned/killed. Valves shall remain in place. Deliver all valve covers, valve boxes and extension stems to the Owner’s storage yard.

3. Backfill excavations with suitable material and compact. Install 6-inch graded aggregate base and repave area as required and as directed by the Engineer.

+ + + END OF SECTION 02665 + + +

SECTION 02821

HIGH SECURITY CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SCOPE

A. The overall design for perimeter security using high security fences and gates to demonstrate a security presence to all onsite staff and visitors. The high security fence and gates shall be constructed of chain link materials, fabric where required, control gates for entrance, parking and exiting the facilities.

B. The work in this section shall include furnishing all labor, materials, equipment and appliances necessary to complete all Structural Gate System(s) and Pedestrian Swing Gate(s) required for this project in strict accordance with this specification section and drawings. The gate and operator shall be specifically designed to complement each other as a system and be provided by a single manufacturer. Components (operator from one source and gate panel from another) assembled at the job site to form a system will not be approved.

1.02 SECTION INCLUDES

A. Fence framework, fabric, and accessories.

B. Excavation for post bases; concrete foundation for posts.

C. Manual gates and related hardware.

D. Barriers.

E. Exit devices.

F. Control gates controllers.

1.03 SUBMITTALS

A. See Section 01350, Project Document Tracking and Control Systems.

B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

C. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

D. Provide manufacturer's catalog cuts with printed specifications and installation instructions.

E. Furnish detailed sequence of operation (description of system). Deliver two (2) copies of operation and maintenance data covering the installed products, including name, address and telephone number of the nearest fully equipped service center.

F. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

G. Shop Drawings:
1. Supply shop drawings showing the relationship of operating systems with other work. Include details of all major components. Include parts list showing manufacturer's names and part numbers for the complete installation.
2. Include complete details of gate construction, gate height, post spacing dimensions and unit weights of structural components.
3. The Structural Cantilever Slide Gate system must be cycle-tested and certified per section 2.01 C.
4. Gates in compliance with ASTM F2200-05, Standard Specification for Automated Vehicular Gate Construction and operators are UL 325 listed per section 2.01 E.
5. The aluminum welders and welding process must be certified per section 2.06 B-2.
6. The steel welders and welding process must be certified per section 2.13 A-3.

1.05 RELATED SECTIONS

Section 02831 – Chain Link Fencing and Gates

1.06 REFERENCES

A. Underwriters Laboratory Gate Operator Requirements (UL 325). See 2.01 E.

B. ASTM F2200-05 – Standard Specification for Automated Vehicular Gate Construction. See 2.01 E.

C. ASTM F 1184 Standard Specification for Industrial and Commercial Horizontal Slide Gates, Type II, Class 2. See 3.02 B.

D. American Welding Society AWS D1.2 Structural Welding Code. See 2.01 D and 2.06 B.2.

E. American Welding Society AWS D1.1 / D1.1M Structural Welding Code. See 2.09 C.

F. ASTM F 1043 Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Like Fence Framework.

G. ASTM 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Chain Link Fences and Gates:

1. Tymetal Corp
2. Ameristar Fence Products
3. Ametco Manufacturing Corp.
4. SecureUSA
5. Payne Fence Products

2.02 CANTILEVER SLIDE GATE MANUFACTURERS

A. The cantilever sliding gate system shall be manufactured by Ameristar Fence Products (Stalwart IS Series) or prior approved equal.

B. Approved substitution – All other systems must be submitted to the design team in accordance with substitution requirements as set forth in the general provisions of the specification manual for approval prior to the bid date. Products submitted after the bid date will not be approved.

C. Cantilever Slide Gate and Operator System manufacturer shall submit test results stating that the gate panel and operator have been tested as a system for 200,000 cycles.

D. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification Records to insure conformance to the AWS D1.2 (aluminum) and AWS D1.1 / D1.1M (steel) Structural Welding Codes. Upon request, Individual Certificates of Welder Qualification documenting successful completion of the requirements of the AWS D1.2 and AWS D1.1 / D1.1M codes shall also be provided. See 1.02 D and 1.02 E.

E. Gate manufacturer shall certify gate is manufactured in compliance with ASTM F2200-05, Standard Specification for Automated Vehicular Gate Construction and the operators are UL 325 listed. See 1.03 C.2.

2.03 SYSTEM DIMENSIONS

Cantilever Slide Gate System dimensions shall be as shown on the detail drawings.

2.04 SYSTEM FUNCTION

Operation:

A. System shall be designed so that gate movement from the closed position is impossible except by electric or mechanical means.

B. Variable Speed-Rate of Travel:

The TYM-VS gate operator shall have the ability to achieve a maximum gate speed of 2.2 feet per second, and shall be equipped with soft-start and soft-stop function to prevent shock load to the gate panel and operator.

2.05 OPERATOR

A. Motor Size:

The electrical motor shall be 1 HP, 208VAC, Three Phase or 230 VAC, Three Phase or 208 VAC, Single Phase or 230 VAC, Single Phase or 460 VAC, Three Phase as produced by a nationally recognized manufacturer.

B. AC Drive:

The variable frequency drive unit shall allow for programmable speeds and programmable soft-start and soft-stop features.

C. Overload Protection:

Motors shall be protected against overload by either a thermal or a current sensing overload device.

D. Gear (Box) Reducer:

The self-enclosed gear-head gearbox shall be manufactured as a single unit, and shall consist of hardened steel, machine cut worm and mating bronze gear running in oil bath. Oil shall be # 634 specialty oil with a fluid pour point of –44 degrees F. The gearbox shall perform the following functions:

a. Adjustable Clutching Device.
b. Manual disconnect by crank handle.

E. Gear Box Heater:

Operator shall include internal gearbox heater and a heater strip for the control box.

F. Drive – Chain:

A #50 roller chain shall be utilized. All chain brackets and required attachment hardware shall be supplied.

G. Manual Operation:

A crank handle, located at ground level in the motor box, shall provide a two-step emergency procedure for manual operation:

a. Unlock and open motor-box door.
b. Fold out handle and crank gate opened or closed.

H. Limits:

1. The operator shall be equipped with an integral limit system, providing accurate settings to control the open and close positions of the gate, and shall not be
2. Affected by manual operation or motor removal.

I. Control Circuit:

U.L. listed operator shall have 5vdc controls.

J. Control wiring:

The electrical contractor shall supply all exterior control wiring.

K. Audio Alarm:

This alarm shall have a dual function.

a. The first function shall be as a warning prior to gate movement. When the motor control board recognizes a command, this alarm shall be activated three (3) seconds before the motor is energized and the gate begins to move. This shall be continuously activated while the gate is in motion.

b. For UL Class III operation only, the audio alarm shall be an entrapment notification alarm. This alarm shall sound as a result of a second activation of the external primary entrapment prevention device before an end limit (open or close) is reached. The pulsing rate of the alarm in the entrapment notification mode shall be faster than the pulsing rate when in the warning mode prior to gate movement.

L. Main Power Disconnect Switch and Wiring Compartment:

When this switch is in the OFF position, the main power shall be disconnected from the Variable Speed Drive, Motor Control Board and power transformer(s).

M. Speed:

The gate operator speed shall be fully programmable allowing a maximum speed of 2.2 feet per second.

N. Transformer:

Operators shall have an isolated low voltage (24V) secondary circuit supplied by a Class II transformer (minimum of 40va) to provide separate power for external control devices (not including external gate lock).

O. Auto Close Timer:

The timer provides an automatic closure of the gate from the full open position, adjustable from 2 to 60 seconds.

P. Ground Loop Sensors:

Provide a two (2) or three (3) ground loop sensor system as required for each location. Number of ground detection loops shall be determined by the gate motor and control manufacturer.

2.06 MOTOR HOUSING

A. Water Resistant Motor Box:

The motor box shall be constructed of 10-gauge sheet steel, hot-dip galvanized per ASTM 123, gasketed and located at ground level for easy maintenance.

B. Security Hinges and Tamper Resistant Security Screws:

Security hinges and screws shall be furnished to secure operator enclosure components.

C. Motor Box Lock:

Motor box shall be locked with a prison dead bolt. Three (3) paracentric keys shall be provided per key code.

2.07 STRUCTURAL SLIDING GATE PANEL

A. Gate Frame:

The gate frame shall be fabricated from 6063-T6 aluminum alloy extrusions. The top member is a 3" x 5" (76mm x 127mm) aluminum structural channel/tube weighing not less than 3.0 lb/lf (4.3kg/m). This is also referred to as a "large primary". This member shall be "keyed" to interlock with the "keyed" track member. If fabricated as a single horizontal piece, the bottom member shall be a 2" x 5" (51mm x 127mm) aluminum structural tube weighing not less than 2.0 lb/lf (2.9kg/m). If fabricated in two horizontal pieces, the bottom member shall be a 5" (127mm) aluminum structural channel weighing not less than 2.65 lb/lf (3.8kg/m). When the gate frame is manufactured in two horizontal pieces or sections, they shall be spliced in the field. The vertical members at the ends of the opening portion of the frame shall be "P" shaped in cross sections with a normal base dimension of no less than 2" x 2" (51mm x 51mm) and weighing not less than 1.6 lb/lf (2.3kg/m). The intermediate vertical members shall alternate between 2" x 2" (51mm x 51mm) and 1" x 2" (25mm x 51mm) in cross section weighing not less than 1.1 lb/lf (1.6kg/m) and 0.82 lb/lf (1.2kg/m) respectively. The spacing for the vertical intermediates shall be less than 50% of the gate frame height.

B. Fabrication:

1. The gate frame shall be fabricated in one or multiple sections depending on size requirements or constraints. See submittal drawings for details.
2. All welds on the gate frame shall conform to Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.2 Structural Welding Code. All individual welders shall be certified to AWS D1.2 welding code. See 1.02 D.

C. Gate Track:

The gate shall have two (2) separate semi-enclosed "keyed" tracks, extruded from 6105-T5 aluminum alloy weighing not less than 2.9 lb/lf (4.2kg/m). Track members to be located on each side of the top member. When interlocked and welded to the "keyed" top member, it forms a composite structure with the top of the gate frame. Welds to be placed alternately alone the top and side of the track at 9" (229mm) centers with welds being a minimum of 2" (51mm).

D. Gate Mounting:

The gate frame is to be supported from the tracks by four (4), swivel-type, self-aligning, 4-wheeled, sealed lubricant ball-bearing truck assemblies. Each truck is to be attached to a hot dipped, galvanized steel hanger bracket which in turn is to be attached to a 4" O.D. (102mm) support post. The bottom of each inside support post is to be equipped with a pair of 3" (76mm) UHMW guide wheels.

E. Diagonal Bracing:

Diagonal "X" bracing of 3/16" (5mm) minimum diameter stainless steel aircraft cable shall be installed to brace the gate panels and to provide a ready means of vertical adjustment.

F. Posts:

All posts shall be minimum 4" O.D. (102mm) round or 4" (102mm) square galvanized steel in accordance with ASTM F 1043. All posts shall be supported in concrete footings as specified by the design team.

G. Gate Filler:

1. Ornamental Picket: Picket sizes shall be (1" or ¾") (25mm or 19mm) square. Pickets may extend through only the clear opening portion or through the entire length of the gate as required. If the specified picket spacing allows for openings in the gate frame that exceed 2¼" (57mm), a secondary gate filler shall be secured at each end of the gate frame and tied at each vertical member. The secondary gate filler shall extend to a minimum height of 48" (1.2m) above grade and shall be sized to prevent a 2¼" (57mm) diameter sphere from passing through openings anywhere along the length of the gate frame. Gate system can be powder coated (custom colors are available – see shop drawings for color requested).
2. Chain link: The material to be used will be specified by the design team as shown on the detail drawings. Gate filler shall extend the entire length of the gate (including the clear opening and counterbalance) and shall be secured at each end of the gate frame by standard fence industry tension bars and tied at each vertical member with standard fence industry ties. The gate filler shall extend to a minimum height of 48" (1.2m) above grade and shall be sized to prevent a 2¼" (57mm) diameter sphere from passing through openings anywhere along the length of the gate frame.

H. Gate Finish:

Gate to be mill finish aluminum or color coated with polyester powder as specified by the design team. If powder coated, the gate (including track member) and all accessories shall be pretreated chemically by sand blasting or other acceptable method to ensure proper coating adherence. Gate posts (to be supplied by others) shall be galvanized or coated as specified by the owner.

I. Gate Lock:

1. Gate system shall be furnished with a secure gate catcher. The catcher shall prevent the gate panel from being pried open while the gate is in the closed and locked position.
2. Gate system shall be furnished with an electro-mechanical lock. Lock shall be supplied with status indication and with a six tumbler mechanical lock. All gates shall be keyed alike. Lock requires additional 115V power supplied by others.

2.08 CONTROLS

A. UL listed Class III or IV Operator

1. Constant pressure on the pushbutton control (with the gate in line of sight in a supervised application) is required as a primary entrapment protection device to keep the gate in motion. When the pushbutton is released, the gate will stop. The secondary entrapment device shall be the inherent audio alarm. An auto-close timer shall not be used with constant pressure control as the primary entrapment protection device.
2. Momentary contact control with non-contact sensor and alarm. Non-contact sensors shall provide external primary entrapment protection system and must be installed for both close and open gate directions. When this equipment is installed, momentary contact on the pushbutton control will start or stop gate movement. The secondary entrapment device shall be the inherent audio alarm. The built-in auto-close timer may be used to automatically close the gate from a full open position after a user set time (from 2-60 seconds).

B. For Class III or IV operation with Momentary Contact Control - Two Albano IR-55 Photo-beams are to be provided with the operator as devices to provide primary entrapment protection under the UL 325 guidelines. The provision of the above photo-beams does not alleviate the installing contractor from the responsibility of identifying and providing protection from safety hazards (entrapment zones) under UL 325 standards for Class III or IV installations. The secondary entrapment protection device provided shall be the inherent audio alarm.

C. The installing contractor shall be responsible to ensure that appropriate external primary entrapment safety devices be installed for the specific site conditions to protect against all potential entrapment zones. Proper operation of these safety devices shall be verified and training as to the operation and maintenance of these devices for the users and owners shall be documented.

2.09 CONTROLS FOR ELECTRICALLY OPERATED CANTILEVER SLIDING GATES (UL Class III or IV)

Select and specify access control devices for this specification section. Operator compatible with most industry accessories.

2.10 PEDESTRIAN SWING GATE MANUFACTURERS

A. The Pedestrian Swing Gate Systems shall be manufactured by Ameristar Fence Products (Stalwart IS Series)

B. Approved substitution – All other pedestrian swing gate systems must be submitted to the design team in accordance with substitution requirements as set forth in the general provisions of the project manual for approval prior to the bid date. Products submitted after the bid date will not be approved.

C. Gate manufacturer shall provide independent certification as to the use of a documented Welding Procedure Specification and Procedure Qualification Record to insure conformance to the AWS D1.1 / D1.1M Structural Welding Code – Steel. Upon request, Individual Certificates of Welder Qualification documenting successful completion of the requirements of the AWS D1.1 / D1.1M code shall also be provided. See 1.02 E.

D. Store gate frames on building site, in an upright position, under cover, on wood sills or floors, and in a manner that prevents rust or damage. Ventilate canvas or plastic covers to prevent moisture traps.

E. All pedestrian gates shall be equipped with a heavy duty, spring loaded (automatic close) hinge.

2.11 SYSTEM DIMENSIONS

Each gate shall have a clear gate opening width of 3 feet 6 inches (1.07m) (minimum) and a gate height of 8 feet 0 inches (2.13m) or as defined in the project drawings.

2.12 SYSTEM FUNCTION

A. General Description:
Pedestrian Swing Gate System shall be designed as an exterior security swing gate.

B. Operation:
When the gate is in the closed position, it shall be impossible for the gate to be opened except by electrical or mechanical means.

C. Pedestrian Swing Gate Lock:
Gate shall be furnished with an electro-mechanical lock.

D. Self-Closing:
The Pedestrian Swing Gate System shall be equipped with a door closer.

E. Door Position Indication Switch:
The Pedestrian Swing Gate System shall be equipped with a door position switch.

2.13 SYSTEM COMPONENTS

A. Security Gate Panel Filler:
Provide gate panel filler where needed.

B. Coating:
The entire gate frame and door assembly shall be hot-dip galvanized after welding.

C. Hinges:
Two (2) needle bearing hinges per gate shall be furnished and shall have a thrust capacity (door weight) of 600 lbs per pair.

D. Electro-mechanical Lock:
Electro-mechanical swing gate lock, keyed both sides, shall be supplied with three keys per key code.

E. Door Closer:
Door closer case and internal parts shall be steel and cast iron with constant viscosity liquid from 120 degrees F to -30 degrees F. Rust inhibitor paint shall be applied.

F. Door Position Indicator Switch:
Rotary door position switch shall be TYM – 8750/16353.

2.14 FABRICATION

A. General:
1. Pedestrian Swing Gate systems shall be fully assembled at the factory and shipped to the project site ready for installation.

2. Steel members shall be straight, true and free from dents, buckle, twist or rough edges. All joints shall be tight metal-to-metal welded finish. All welds shall show uniform section and deep penetration. Clean weld spatter off so that surfaces are easily cleaned.
3. All welds on the gate frame shall conform to Welding Procedure Specification and Procedure Qualification Record to insure conformance to AWS D1.1 / D1.1M Structural Welding Code – Steel. All individual welders shall be certified to AWS D1.1 / D1.1M welding code.

B. Frames, Stiles and Rails:

Steel members shall be tubular in cross-section with a minimum wall thickness of 3/16" (5mm). Members shall be mitered and welded at the corners.

2.15 FINISH

Galvanizing:

All exposed system parts shall be zinc galvanized or as otherwise specified.

PART 3 EXECUTION

3.01 SITE INSPECTION

Final grades and installation conditions shall be examined. Installation shall not begin until all unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Equipment in this section shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.

B. The Fortress cantilever slide gate system and installation shall conform to ASTM F 1184 standards for aluminum cantilever slide gates, Type II, Class 2. See 1.02 C.

C. The gate system is to comply with ASTM F2200 and UL 325. See 1.02 B and 1.02 A respectively.

3.03 SYSTEM VALIDATION:

A. The complete system shall be adjusted to assure it is performing properly.

B. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

C. Test and Explain Safety Features:
   1. Each system feature and device is a separate component of the gate system.
   2. Read and follow all instructions for each component.
   3. Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.
   4. The warning signs shipped with the gate operator must be installed in prominent position on both sides of the gate.

D. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the operator manual and must be read prior to system use.

+++END OF SECTION+++

SECTION 02831

CHAIN LINK FENCING AND GATES

PART 1 GENERAL

1.01 SCOPE

Extent of chain link fences, gates and motors as indicated on drawings.

1.02 RELATED SECTIONS

A. Division 1 Sections

B. Section 02821 – High Security Chain Link Fences and Gates

1.03 SUBMITTALS

Product Data: Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, gates and accessories.

1.04 QUALITY ASSURANCE

Provide chain link fences and gates as complete units controlled by a single source including necessary erection accessories, fittings, and fastenings.

PART 2 PRODUCTS

2.01 GENERAL

A. Dimensions indicated for pipe, roll-formed, and H-sections are outside Dimensions, exclusive of coatings.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include; but are not limited to, the following:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   a. Galvanized Steel Fencing and Fabric:
      1) Allied Tube and Conduit Corp.
      2) American Fence Corp.
      3) Anchor Fence, Inc.
   b. Aluminum Fencing and Fabric:
      1) Chain Line Fence Company of Pennsylvania
      2) Security Fabricators, Inc.
      3) Boundary Fence & Railing Systems, Inc.
   c. Bared Tape:
      1) American Fence Corp.
      2) Man Barrier Corp.
      3) Boundary Fence & Railing Systems, Inc.
   d. Gate Motor and Housing:
      1 Door King
      2) Linear Corp.
   e. Gate Arms and Assembly:
      1) Magnetic Auto Control
      2) Cincinnati Gate Systems

2.02 STEEL FABRIC

A. Fabric: No. 9 gauge (0.148” t 0.005”) size steel wires, 2” mesh, with top selvages knuckled for fabric 60” high and under, and both top and bottom selvages twisted and barbed for fabric over 60” high:

Furnish one-piece fabric widths for fencing up to 12’ high.

B. Fabric Finish: Galvanized, ASTM A 392, Class II, with not less than 2.0 oz. zinc per sq. ft. of surface.

C. Fabric Finish: Aluminized, ASTM A 491, Class II, with not less than 0.40 oz. aluminum per sq. ft. of surface.

D. Fabric Finish: Galvanized, ASTM A 392, Class I, with not less than 1.2 oz. zinc per sq. ft. of surface.

E. Fabric Finish: Minimum 7-mil polyvinyl chloride (PVC) plastic resin finish over galvanized steel wire. Color as selected by Architect from manufacturer’s standard color selection:

1. Comply with ASTM F 668, Class 2.
2. Comply with ASTM F 668, Class 2, except provide fabric with diameter (gage) of core wire equivalent to fabric diameter specified when measured prior to application of non-metallic coating.
3. Comply with ASTM F 668, Class 1.

2.03 FRAMING AND ACCESSORIES

A. Steel Framework, General: Galvanized steel, ASTM A 120 or A 123, with not Less than 1.8 oz. Zinc per sq. ft. of surface.

1. Fittings and Accessories: Galvanized, ASTM A 153, with zinc weights per Table I.
2. Steel Framework Finish: Provide framework, fittings and accessories in accordance with manufacturer's standard thermally bonded polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010") thick. Color to match chain link fabric.

B. Aluminum Framework, General: ASTM B 221, Alloy 6063, mill finished aluminum.

Fittings and Accessories: Mill finished aluminum or galvanized steel, to suit manufacturer's standards.

C. End, Corner and Pull Posts: Minimum sized and weights as follows:

1. Up to 6' fabric height, 2.375" OD steel pipe, 3.65 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
2. Over 6' fabric height, 2.875" OD steel pipe, 5.79 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
3. Either 2.875" OD aluminum pipe 2.0 lbs. per linear ft. or 2.50" square tubing, 2.9 lbs per linear ft.

D. Line Posts: Space 10' o.c. maximum, unless otherwise indicated, of following minimum sized and weights.

1. Up to 6' fabric height, 1.90" OD steel pipe, 2.70 lbs per linear ft. or 1.875" x 1.625" C-sections, 2.28 lbs per linear ft.

2. 6’ to 8’ fabric height, 2.375” OD steel pipe, 3.65 lbs per linear ft. or 2.25” x 1.875” H-sections, 2.64 lbs linear ft.
3. Over 8’ fabric height, 2.875” OD steel pipe, 5.79 lbs per linear ft. or 2.25” x 1.875” H-sections, and 3.26 lbs per linear ft.
4. Up to 8’ fabric height, either 2.375” OD aluminum pipe, 1.26 lbs per linear ft. or 2.25” x 1.875” H-section, 1.25 lbs per linear ft.
5. Over 8’ fabric height, 2.875” OD aluminum pipe, 2.0 lbs per linear ft.

F. Gate Posts: Furnish posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:

G. Steel Fencing

Leaf Width	Gate Post	lbs/ linear ft.
Up to 6’	3.5”x3.5” roll-formed section	4.85
	or 2.875” OD pipe	5.79
Over 6’ to 13’	4.000” OD pipe	9.11
Over 13’ to 18’	6.625” OD pipe	18.79
Over 18’	8.625” OD pipe	28.55

H. Aluminum Fencing

Leaf Width	Gate Post	lbs/linear ft.
Up to 6’	2.875” OD	2.004
Over 6’ to 13’	4.000” OD	3.151
Over 13’ to 18’	6.625” OD	6.564
Over 18’	8.625” OD	9.878

I. Top Rail: Manufacturer’s longest lengths, with expansion type couplings, approximately 6” long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post.

1. Steel fencing: 1.66” OD pipe, 2.27 lbs. per ft. or 1.625” x 1.25” roll-formed sections, 1.35 lbs. per ft.
2. Aluminum fencing: 1.66” OD pipe, .86 lbs per ft.

J. Tension Wire: 7-gage, coated coil spring wire, metal and finish to match fabric.

Locate at bottom and top of fabric.

K. Wire Ties: 11 gauge galvanized steel of 11-gauge aluminum wire, to match fabric core material.

L. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line post with 0.375" diameter rod and adjustable tightener.

M. Post Tops: Provide weathertight closure cap with loop to receive tension wire or top rail; one cap for each post.

N. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16" x 3/4". Provide one stretcher with bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.

O. Stretcher Bar Bands: Space not over 15" o.c., to secure stretcher bars to end, corner, pull, and gateposts.

P. Barbed Wire Supporting Arms: Manufacturer's standard barbed wire supporting arms, metal and finish to match fence framework, with provision for anchorage to posts and attaching 3 rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap and must be capable of withstanding 250 lbs. downward pull at outermost end. Provide following type:

Single 45-degree arm; for 3 strands barbed wire, one for each post.

Q. Barbed Wire: 2 strand 12-1/2 gauge. Wire with 14 gauge. 4-point barbs spaced not more than 5" o.c.; metal and finish to match fabric.

2.04 GATES

A. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding or with

special fittings and rivets for rigid connections, providing security against removal or breakage connections. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories. Space frame member's maximum of 8' apart unless otherwise indicated.

1. Provide same fabric as for fence, unless otherwise indicated. Install fabric with stretcher bars at vertical edges and at top and bottom edges. Attach stretcher bars to gate frame at not more than 15' o.c.
2. Install diagonal cross bracing consisting of 3/8" diameter adjustable length truss rods on gates to ensure frame rigidity without sag or twist.
3. Where barbed wire is indicated above gates, extend end members of gate frames 1"-0" above to member and prepare to receive 3 strands of wire. Provide necessary clips for securing wire to extensions.

B. Swing Gates: Fabricate perimeter frames of minimum 1.90" OD pipe.

C. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153, and in accordance with the following:

1. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 degree gate opening. Provide 1-1/2 pair of hinges for each leaf over 6' nominal height.
2. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
3. Keeper: Provide keeper for vehicle gates, which automatically engages gate leaf and holds it in open position until manually released.
4. Double Gates: Provide gate stops for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.

D. Concrete: Provide concrete consisting of Portland cement, ASTM C 150, aggregates ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3000 psi

using at least 4 sacks of cement per cu. Yd., 1" maximum size aggregate, maximum 3" slump, and 2% to 4% entrained air.

2.07 GATE MOTOR

Gate Motor shall self-adjusting, no maintenance magnetic limits, partial-open feature, anti-tailgating feature, gate tracker reporting output and ports for plug-in loop detectors. DC Powered Convenience Open (Optional). Two convenience outlets, fail-safe release (fail-secure optional), programming switches, built-in reset switch and built-in power on/off switch.

A. AC Drive:

B. The variable frequency drive unit shall allow for programmable speeds and programmable soft-start and soft-stop features.

C. Overload Protection:

D. Motors shall be protected against overload by either a thermal or a current sensing overload device.

E. Gear (Box) Reducer:

F. The self-enclosed gear-head gearbox shall be manufactured as a single unit, and shall consist of hardened steel, machine cut worm and mating bronze gear running in oil bath. Oil shall be #634 specialty oil with a fluid pour point of –44 degrees F. The gearbox shall perform the following functions:

1. Adjustable Clutching Device.
2. Manual disconnect by crank handle.

G. Gear Box Heater:

H. Operator shall include internal gearbox heater and a heater strip for the control box.

I. Drive – Chain:

J. A #50 roller chain shall be utilized. All chain brackets and required attachment hardware shall be supplied.

K. Manual Operation

L. A crank handle, located at ground level in the motor box, shall provide a two-step emergency procedure for manual operation:

1. Unlock and open motor-box door.
2. Fold out handle and crank gate opened or closed.

M. Limits: The operator shall be equipped with an integral limit system, providing accurate settings to control the open and close positions of the gate, and shall not be affected by manual operation or motor removal.

N. Control Circuit: U.L. listed operator shall have 5vdc controls.

O. Control wiring: The electrical contractor shall supply all exterior control wiring.

P. Audio Alarm: This alarm shall have a dual function.

1. The first function shall be as a warning prior to gate movement. When the motor control board recognizes a command, this alarm shall be activated three (3) seconds before the motor is energized and the gate begins to move. This shall be continuously activated while the gate is in motion.
2. For UL Class III operation only, the audio alarm shall be an entrapment notification alarm. This alarm shall sound as a result of a second activation of the external primary entrapment prevention device before an end limit (open or close) is reached. The pulsing rate of the alarm in the entrapment notification mode shall be faster than the pulsing rate when in the warning mode prior to gate movement.

Q. Main Power Disconnect Switch and Wiring Compartment:

When this switch is in the OFF position, the main power shall be disconnected from the Variable Speed Drive, Motor Control Board and power transformer(s).

R. Speed: The gate operator speed shall be fully programmable allowing a maximum speed of 2.2 feet per second.

S. Transformer: Operators shall have an isolated low voltage (24V) secondary circuit supplied by a Class II transformer (minimum of 40va) to provide separate power for external control devices (not including external gate lock).

T. Auto Close Timer: The timer provides an automatic closure of the gate from the full open position, adjustable from 2 to 60 seconds.

U. Ground Loop Sensors:

Provide a two (2) or three (3) ground loop sensor system as required for each location. Number of ground detection loops shall be determined by the gate motor and control manufacturer.

2.06 GATE MOTOR HOUSING:

A. Water Resistant Motor Box

B. The motor box shall be constructed of 10-gauge sheet steel, hot-dip galvanized per ASTM 123, gasketed and located at ground level for easy maintenance.

C. Security Hinges and Tamper Resistant Security Screws

D. Security hinges and screws shall be furnished to secure operator enclosure components.

E. Motor Box Lock:

Motor box shall be locked with a prison dead bolt. Three (3) paracentric keys shall be provided per key code.

F. Compliant with UL 325 and 991. ETL listed.

G. To be compliant with UL 325 and industry safety guidelines, a secondary entrapment prevention device(s) is required to be installed with this gate operator.

H. Welded heavy-duty frame.

I. Heavy duty 10:1 gear reducer allows emergency manual operation without tools.

J. Fail secure lock standard (gate locks when power off).

K. Overload sensing system.

L. MVP "smart" radio receiver with FC antenna.

M. Built-in operator lock, auto close timer, maximum run timer and master/second capability.

N. Solid-state circuitry with diagnostic LED readout.

O. UL Listed for UL 325 (Class I-IV) for U.S. and Canada (120 VAC only) -HS (Class III-IV only).

PART 3 EXECUTION

3.01 INSTALLATION

A. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

B. Excavation: Drill or hand excavate (using post hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.
2. Unless otherwise indicated, excavate hole depths approximately 3” lower than post bottom, with bottom of posts set not less than 36” below finish grade surface.
3. Setting Posts: Center and align posts in holes 3” above bottom of excavation.
4. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

5. Unless otherwise indicated, extend concrete footings 2” above grade and trowel to a crown to shed water.

C. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

D. Center Rails: Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.

E. Brace Assemblies: Install braces as posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 ga. galvanized wire. Fasten fabric to tension wire using 11 ga. Galvanized steel hog rings spaced 24” o.c.

G. Fabric: Leave approximately 2” between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

H. Stretcher Bars: Thread through or clamp to fabric 4” o.c., and secure to posts with metal bands spaced 15” o.c.

I. Barbed Wire: Pull wire taut and install securely to extension arms and secure to end post or terminal arms in accordance with manufacturer’s instructions.

J. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

K. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing. Tie fabric to line posts, with wire ties spaced 12” o.c. Tie

fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24"o.c.

L. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

M. Equipment in this section shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.

N. Gate system and installation shall conform to ASTM F 1184 standards for aluminum cantilever slide gates, Type II, Class 2. The gate system is to comply with ASTM F2200 and UL 325. See 1.02 B and 1.02 A respectively.

O. The complete system shall be adjusted to assure it is performing properly. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

P. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the operator manual and must be read prior to system use

Q. Test and Explain Safety Features:

1. Each system feature and device is a separate component of the gate system.
2. Read and follow all instructions for each component.
3. Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.
4. The warning signs shipped with the gate operator must be installed in prominent position on both sides of the gate.

+++END OF SECTION+++

SECTION 02920
SITE RESTORATION

PART 1 GENERAL

1.01 SCOPE

A. The Contractor shall provide all, labor, materials, equipment and incidentals required for all site restoration and related operations necessary shown on the Drawings or specified in these Specifications.

B. This section includes disposition of materials and structures encountered in the Work, all cleanup and any other similar, incidental, or appurtenant operations which may be necessary to properly complete the Work.

1.02 SUBMITTALS

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

1. The Contractor shall submit certificates of inspection as required by government authorities. The Contractor shall submit other data substantiating that materials comply with specified requirements.

2. The Contractor shall submit instructions recommending procedures to be established by the City for maintenance of site restoration work for one (1) full year.

1.03 QUALITY ASSURANCE

A. The Contractor shall ship site restoration materials with certificates of inspection required by authorities having jurisdiction. The Contractor shall comply with regulations applicable to site restoration materials.

B. If specified site restoration materials are not obtainable, the Contractor shall submit proof of non-availability to the Engineer together with proposal for use of equivalent material.

1.04 SAFETY REQUIREMENTS

A. Hazards Control:

1. The Contractor shall store volatile wastes in covered metal containers, and remove from the site of the Work daily.

2. The Contractor shall prevent accumulation of wastes that create hazardous conditions.

3. The Contractor shall provide adequate ventilation during use of volatile or noxious substances.

B. The Contractor shall conduct cleaning and disposal operations in compliance with local ordinances and environmental laws and regulations.

1. The Contractor shall not burn or bury rubbish and waste materials on the site of the Work without prior written permission from the Engineer.

2. The Contractor shall not dispose of volatile wastes such as mineral spirits, oil, or fuel in open drainage ditches or storm or sanitary drains.

1.05 DELIVERY

The Contractor shall deliver packaged materials in containers showing weight, analysis, and name of manufacturer. The Contractor shall protect materials from deterioration during delivery and while stored at the site of the Work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.01 DISPOSITION OF MATERIALS AND STRUCTURES ENCOUNTERED IN THE WORK

A. Existing materials or structures that may be encountered (within the lines, grades, or trenching sections established for completion of the Work), if unsuitable or unacceptable to the Engineer for use in the Work, and for which the disposition is not otherwise specified, shall either be disposed of by the Contractor or shall remain the property of the City as further provided in this section.

B. At the option of the City, any existing materials or structures of "value" encountered in the Work shall remain the property of the City. The term "value" shall be defined by the City.

C. Any existing materials or structures encountered in the Work, and determined not to be of "value" by the City, shall be disposed of by the Contractor, in an approved manner.

3.02 JOB CONDITIONS

A. The Contractor shall determine the locations of underground utilities and perform Work in a manner which will avoid possible damage. The Contractor shall hand excavate, as

required. The Contractor shall maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

B. All bare earth areas within the limit of work shall be grassed, mulched, or covered with other plant material as shown on the Drawings.

C. On a continuous basis, the Contractor shall maintain the site of the Work free from accumulations of waste, debris, and rubbish caused by his operations.

D. At completion of the Work, the Contractor shall remove waste materials, rubbish, tools, equipment, machinery, and surplus materials, and clean all sight-exposed surfaces. The Contractor shall leave the site of the Work clean and ready for occupancy or use.

E. The Contractor shall proceed with the complete site restoration work as rapidly as portions of the site of the Work become available, working within seasonal limitations for each kind of site restoration work required. The Contractor will not be allowed to postpone cleanup and seeding or sodding until the end of the Work.

F. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, the Contractor shall notify the Engineer before planting.

G. The Contractor shall install materials during normal planting seasons for each type of site restoration work.

H. The Contractor shall plant or replace trees and shrubs after final grades are established and prior to planting of lawns, unless otherwise acceptable to the Engineer. If planting of trees and shrubs occurs after lawn work, the Contractor shall protect lawn areas and promptly repair damage to lawns resulting from planting operations. Refer to Section 02900, Trees, Plants and Ground Covers.

I. The Contractor may, at his option, employ additional measures (other than those specified) to prevent loss of, or damage to the Work resulting from the effects of wind and/or water. No additional compensation will be made for the employment of such additional measures.

3.03 CLEANUP

A. During site restoration work, the Contractor shall keep pavements clean and the site of the Work in an orderly condition.

B. The Contractor shall protect site restoration work and materials from damage due to site restoration operations, operations by other contractors, and trades and trespassers. The Contractor shall maintain protection during installation and maintenance periods. The Contractor shall treat, repair, or replace damaged site restoration work as directed by the Engineer.

C. Immediately upon completion of any section of the Work and before payment therefore has been made, the Contractor shall remove from the site of the Work all construction equipment, temporary structures, and debris, and shall restore the site of the Work to a condition equal to or better than that which existed prior to construction. Waste materials shall be disposed of at locations satisfactory to the City or affected regulatory agencies.

D. The Contractor shall not remove barricades and warning and direction signs until directed by the Engineer.

E. After completion of all Work required by the Contract and before final payment has been made, the Contractor shall make a final cleanup of each separate part of the Work; shall restore all surfaces to a neat and orderly condition; and shall remove all construction equipment, tools, and supplies.

3.04 INSPECTION AND ACCEPTANCE

A. When site restoration work is completed, including maintenance, the Engineer will, upon request, make an inspection to determine acceptability.

B. Where inspected site restoration work does not comply with the requirements of the Engineer, the Contractor shall replace rejected work and continue specified maintenance until reinspected by the Engineer and found to be acceptable. The Contractor shall remove rejected plants and materials promptly from the site of the Work.

+ + + END OF SECTION 02920 + + +

SECTION 02933
SEEDING AND SODDING

PART 1 GENERAL

1.01 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.

1.02 SUBMITTALS

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

1. Prior to seeding operations, labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this Section.
2. Prior to topsoil operations, the Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Services or other certified testing laboratory.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Wood cellulose fiber mulch shall be manufactured by Weyerhauser Company or Conway Corporation.

2.02 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

3.01 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.

3.02 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.

3.03 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.

3.04 SEEDING

A. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the 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.

3.05 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:

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.

3.06 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.

3.07 MAINTENANCE

A. Upon completion of seeding operations, the Contractor shall clear the area of all equipment, debris and excess material and the premises shall be left in a neat and orderly condition.

B. The Contractor shall maintain all seeded 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.

D. 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 02933 + + +

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 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.

1.02 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.

1.03 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.

1.05 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

2.01 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

3.01 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, Concrete 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.

3.02 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.

Form releasing agents must not impair subsequent treatment of concrete surfaces that depend upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. 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.

3.04 FIELD QUALITY CONTROL

A. Before concrete placement, the Engineer shall inspect all formwork. No concrete shall be poured without Engineer's approval.

B. Before concrete placement, Contractor shall check the formwork, including lines, ties, tie cone, and form coatings. 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.

3.05 REMOVAL OF FORMS

A. Remove forms and falsework in a manner that will prevent damage to the concrete and not impair the safety of the structure.

B. Do not use pinch bars or similar tools to pry against concrete surfaces.

C. Do not remove forms until concrete has aged as follows:

1. Elevated slabs and beams: 7 days minimum.
2. Grade beams, columns, walls, construction and expansion joint bulkheads and other vertical surfaces: 24 hours minimum.

D. Elevated slabs and beams shall have attained at least 70 percent of the specified 28 day strength before form removal. Concrete shall also have sufficient strength to safely support its own weight and construction loads. Determine concrete strength for form removal in conformance with ACI 301.

E. Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28 day design strength.

F. Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live load of the elements

3.06 REUSE OF FORMS

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.

1. 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.
2. Metal surfaced forms must have a smooth even surface without plate patches.

+ + + END OF SECTION 03100 + + +

SECTION 03200
CONCRETE REINFORCEMENT AND DOWELLING

PART 1 - GENERAL

1.01 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.
5. Section 03605, Dowelling Into Existing Concrete.

1.02 SUBMITTALS

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

1. 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.
2. Copies of manufacturer's specifications and installation instructions for all materials and reinforcement accessories.
3. 5 copies of steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

1.03 QUALITY ASSURANCE

A. Contractor shall examine the substrate and the conditions under which concrete reinforcement is to be placed, and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. 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.

1.04 DELIVERY STORAGE AND HANDLING

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, length, and other information corresponding to markings shown on placement diagrams.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 - PRODUCTS

2.01 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.

2.02 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

3.01 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.

3.02 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 03200 +++

SECTION 03250
CONCRETE JOINTS

PART 1 - GENERAL

1.01 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.

1.02 SUBMITTALS

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

1. Product data for all materials stating the location where product is to be used.
2. Certification that materials meet the specifications.
3. Manufacturer's application and installation instructions.
4. Samples of water stops, concrete roughener, joint fillers, caulk and bonding agent if requested by the Engineer.

1.03 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

2.01 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.

2.02 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.

2.03 JOINT FILLER

Expansion Joint Material: Type I, preformed sponge neoprene expansion joint filler conforming to AASHTO Designation M-153.

2.04 WATERSTOPS

Waterstop shall be PVC (Polyvinylchloride) meeting ASTM D-638 test method for tensile strength of 2020 psi and ultimate elongation of 370.

1. Construction joints:
   a. Serrated with center bulb, 3/8" thick by 6" minimum width, Greanstreak #706 or equal.
   b. Preformed plastic adhesive waterstop, Synko-Flex Products or equal. Use only where shown on Drawings.
2. Expansion Joints: Serrated with center bulb, 3/8" thick by 9" minimum width, Greanstreak #738 or equal.

PART 3 - EXECUTION

3.01 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, Grout.
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 coating per. Section 09900, Painting.
7. Install appliances per drawings and specifications.

3.02 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 03250 +++

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 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. Refer to the drawings for their locations.

1. Class A
2. Class B
3. Class C
4. Class D
5. Class E
6. Class F
7. Class G

1.02 SUBMITTALS

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

1. 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.
2. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
3. 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.

4. Notarized certification of conformance to referenced standards to the Engineer and a copy of the batch plant's most recent scale calibration.
5. 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.

1.03 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. By Contractor's Testing Laboratory:

   a. 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.
      1) Testing agency shall meet the requirements of ASTM E 329.
      2) 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.
      3) Submit certification that the testing laboratory meets the requirements of ASTM E329.
   b. 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. Tests not specifically indicated to be done at the City's expense, including the retesting of rejected materials and installed Work, shall be done at the Contractor's expense.

2. By Independent Testing laboratory

   Testing for concrete field quality control as specified under Paragraph 3.14 of this Specification, shall be performed by an independent testing laboratory approved by the Engineer. The cost of all concrete testing for field quality control shall be paid for by the Contractor and shall be included in the Contractor's base bid. The Contractor shall be responsible for notifying the independent testing laboratory to schedule the testing as specified.

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.

1.04 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

2.01 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.
   a. 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.

2.02 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.

2.03 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
A	4,000	1" – 2"	6" – 9"	0.45	57
B	5000	1" – 2"	6" – 9"	0.40	57
C	6000	1" – 2"	7" – 10"	0.40	67
D	4,500	1" – 2"	6" – 9"	0.42	67
E	1,500	3" – 5"	-	Not specified	67
F	4,000	1" – 2"	6" - 9"	0.45	7
G	3,000	1" – 4"	N/A	0.55	57

*High Range Water Reducer (HRWR)

1. Fly ash is required in Class A, B, C, D & F 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.
2. Fly ash and Silica Fume are required in Class C concrete. The combined weight of the cement, fly ash and silica fume shall contain no less than 15 percent fly ash and no less than 10 percent silica fume. The combined weight of cement, fly ash and silica fume shall be used as the weight of cement in determining the water cement (w/c ratio).
3. 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.
4. 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.
5. 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.

6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. Class D concrete shall have an air content of 6% ± 1½%.
12. Class A concrete shall have 5 $\pm$ 1% air content.
13. Class B concrete shall have 5 $\pm$ 1% air content.
14. The Contractor has the option to use coarse aggregate size 57 or 67 in the Main Tunnel concrete lining.
15. Air entrainment not required in the Main Tunnel concrete lining.

2.04 CHEMICAL HARDENER

Unless otherwise specified, all interior concrete floors of the Electrical Building shall be treated with a liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant for improved wetting penetration. Liquid hardener shall be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent toppings and/or coatings. Liquid hardener shall be suitable for use on new or old concrete floors and shall comply with Corps of Engineer Specification 204.

2.05 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

3.01 CONCRETE MIXING

General:

1. 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.
2. Mixing:
   a. Mix concrete with an approved rotating type batch machine.
   b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
   c. Replace mixer blades when they have lost 10 percent of their original height.
   d. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".
   e. Mix concrete in revolving type truck mixers, which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
   f. Do not exceed the proper capacity of the mixer.
   g. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
   h. Do not allow the drum to sit while in transit.
   i. Mix at proper speed until concrete is discharged.
   j. 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.
   k. 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.

3.02 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not 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.

3.03 CONCRETE PLACEMENT

A. Inspection of Work Before Placing Concrete:

1. Inspect the area to receive concrete for any deficiencies, which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.
2. Do not place in the concrete any item that is not required to be in the concrete by the Drawings and Specifications. Insert all the items shown on the Drawings or specified properly positioned and secured. Openings other than those, which are facilitated by sleeves shall be properly formed and positioned only after approval of the Engineer.
3. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.
4. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable sections of the Specifications for that work.

B. Place concrete continuously so that no concrete will be placed on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure, which will cause segregation.

1. Screed concrete, which is to receive other construction to the proper level to avoid excessive skimming or grouting.
2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and position and secure.
4. Unless otherwise approved, place concrete only when Engineer is present.

D. 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.

E. 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.

F. 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.

G. 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 30^0 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.

H. Hot Weather Placing:

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
2. 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.

3.05 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 adjancent concrete before the neat cements grout takes its initial set.

3.06 WATERSTOPS

Waterstops shall be provide where specified and as indicated and noted on the Drawings and shall be made continuous throughout their length.

3.07 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.

3.08 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.

3.09 WOOD FLOAT FINISH

A wood float finish shall be applied to all base and top slabs in the diversion structures.

3.10 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.

C.

3.11 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.

3.12 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.

D. 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 C of this article of these Specifications.

3.13 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.

3.14 QUALITY CONTOL 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.

3.15 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.

3.16 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 03300 + + +

SECTION 03600
GROUT

PART 1 - GENERAL

1.01 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, Cast-in-Place Concrete for pressure grouting applications.

C. Related Work Specified Elsewhere:

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

1.02 SUBMITTALS

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

1. Copies of manufacturer's specifications and installation instructions for all proprietary materials.
2. Reports and Certificates:
   a. For proprietary materials, submit copies of reports on quality control tests.
   b. For nonproprietary materials, submit certification that materials meet specification requirements.

1.03 QUALITY ASSURANCE

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

1. ASTM C 150, Portland Cement.
2. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
3. ASTM C 191, Time of Setting of Hydraulic Cement by Vicat Needle.
4. CRD-C 588, Specifications for Non-Shrink Grout.

1.04 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

2.01 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-Metalic 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:
   1) Integral Waterpeller by The Euclid Chemical Company.
   2) Omicron, Type OM by Master Builders Company.
   3) Hydrocide Powder by Sonneborn-Contech.
   4) Or Equal.
3. For use at horizontal waterstops only.

D. Water:

Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalies 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

3.01 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, Cast-in-Place Concrete.
   5. Surface to be grouted is to be adequately cured, cleaned dampened and roughened per manufacturer recommendations to insure adequate bonding.

B. 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.

C. Grouting for Waterstops:
   1. Grout for PVC waterstops to be the non-shrink, non-metallic type.Refer to Section 03250, Concrete Joints for installation procedures.
   2. Grout from Redi-mix plant conforming to applicable requirements of Section 03300, Cast-in-Place Concrete may be substituted at no additional compensation to the contractor.

D. 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, Painting prior to installing and grouting.

E. Grouting for Bearing Plates and Equipment:

Use non-shrink, non-metalic grout for setting bearing plates and equipment. Provide a minimum grout thickness of 1".

F. 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, Concrete Framework, 03200, Concrete Reinforcement and Dowelling and 03300, Cast-in-Place Concrete.

+++ END OF SECTION 03600 +++

SECTION 03605
DOWELING INTO EXISTING CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to place reinforcing dowels into existing concrete using a two-component epoxy adhesive as shown and specified.

B. Related Work Specified Elsewhere:

1. Section 02050, Demolition.
2. Section 03300, Cast-in-Place Concrete.
3. Section 03600, Grout.

1.02 SUBMITTALS

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

1. Product Data: Furnish technical data for epoxy adhesives, grouts, and bonding agents suggested for the project work including installation instructions, independent laboratory test results, and handling and storage instructions.
2. Samples: Furnish two random samples of each batch of products delivered to project site, for independent testing.
3. Quality Control Submittals: Furnish the following:
4. Manufacturer's past project experience data on at least three similar projects supplied with proposed products within the last 3 years, to include client name, address, contact person, phone number, project location, and description of work.
4. Batch test reports for each batch of product delivered to site. Provide manufacturer's written certification that each batch delivered meets these Specifications, the intended uses on project, including capability to bond to damp or wet concrete surfaces. Certification shall include batch test results for each product.
5. Manufacturer's written letter of certification identifying Contractor's employees qualified for operation of manufacturer's equipment and certified for installation of products, trained through jobsite instruction conducted by manufacturer.
6. Copy of manufacturer's equipment service and repair manuals for each type of equipment delivered to project site.

7. Copy of manufacturer's service agreement with Contractor for each type of equipment.
8. Procedures for testing and verifying product meets specified requirements.
9. Special Inspection: Provide detailed step-by-step instructions for the special inspection procedure as required by ICBO reports and Section 306 of the Uniform Building Code.

1.03 QUALITY ASSURANCE

A. Contractor shall examine the conditions under which reinforcing dowels are to be placed into existing concrete, and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

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

1. ACI 301, Specifications for Structural Concrete For Buildings.
2. ACI 305, Hot Weather Concrete.
3. ACI 350, Environmental Engineering Concrete Structures.
4. ACI 347, Recommended Practice for Concrete Formwork.
5. ICBO Report No. 4398, April 1988 for Adhesive Technology Corp.

1.04 MANUFACTURERS' SERVICES

Furnish manufacturer's representative to conduct jobsite training for proper installation, handling, and storage of each product delivered to project site, for personnel who will perform actual installation. Engineer will attend training sessions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Like Items of Materials: End products of one manufacturer in order to achieve structural compatibility, singular responsibility, and standardization for maintenance, and replacement.

B. Epoxy Adhesive for Doweling:

1. Meet ASTM C 881, Type 1, Grade 3, Class A, B, or C, depending on site conditions.
2. Two-component, 100 percent solids, nonsag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments and gray in color.

3. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
4. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precaution.

C. Component "A" Base Resin:

1. Modified biphenyl-A type epoxy.
2. Viscosity: Light paste, 350 cps maximum prior to mixing to ensure proper wetting of moist concrete surfaces.
3. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or asbestos.
4. Color: White.

D. Component "B" Hardener or Curing Agent:

1. Viscosity: Light paste.
2. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or asbestos.
3. Color: Black.

E. Mixed Epoxy Adhesive:

1. Nonsag light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout, holding the following properties:
   a. Slant Shear Strength, ASTM C 881/882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
   b. Compressive Strength, ASTM D 695: 14,000 psi, minimum.
   c. Tensile Strength, ASTM D 695: 4,500 psi.
   d. Heat Deflection Temperature, ASTM D 648: 135 degrees F, minimum

2. Manufacturers:
   a. Adhesives Technology Corp, 4210 B Street, N.W., Suite D, Auburn, WA 98001
   b. Anchor-It Fastening Systems, HS 200 Epoxy Resin, telephone 1-800-262-4748.
   c. Or equal.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Epoxy Components:

1. Store epoxy components on pallets or shelving in a covered storage area with locking door.
2. Control temperature above 60 degrees F and dispose of product if shelf life has expired.
3. If stored at temperatures below 60 degrees F, test components prior to use to determine if they still meet specified requirements.

3.02 GENERAL

A. Dispensing, Metering, or Mixing Epoxy Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.

B. Dispense epoxy components through specially designed static mixing nozzle that thoroughly mixes epoxy components and places mixed epoxy at base of predrilled hole.

C. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

D. Where large meter and mixing pumps are impractical, provide epoxy adhesive packaged as follows:

1. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
2. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
3. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of reinforcing dowels.

3.03 TESTING OF AUTOMATIC METERING AND MIXING DEVICES

A. Tests for Proper Ratio:

1. Retain small amount of dispensed adhesive for inspection after each time the pump is refilled.
2. Operator shall check these samples for color change.
3. Should change in color occur, operator shall follow manufacturer's service instructions to obtain proper operation.

B. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.

C. Ratio Check Procedure:

1. Disconnect dispensing head behind ON/OFF valve.

2. Place a 1-cup volume container and a 2-cup volume container under the "B" and "A" component hose ends.
3. Actuate the pump until both cups are filled to a proper proportion of 2:1 by volume.

3.04 DOWEL SIZING AND INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
2. Hollow drills with flushing air systems are preferred.
3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.

B. Hole Diameter:

1. As small as possible to allow dowel to be embedded to required depth.
2. Use drill bit diameter meeting ICBO report requirements.
3. Hole Diameter: Dowel diameter plus 1/8 inch for temperature at time of installation above 60 degrees F, or dowel diameter plus 1/4 inch for temperature at time of installation below 60 degrees
4. For large reinforcing bars No. 8 or greater embedded 18 diameters or more, verify hole diameter with manufacturer.

C. Obstructions in Drill Path:

1. When existing reinforcing steel is encountered during drilling and when approved by the Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or redrill hole 1 inch from original location, beginning in the same line at the surface, redirecting the drill to miss reinforcing steel.
2. Place dowels in both the misdrilled hole and the new one.
3. Dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
5. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
6. Conform to details shown.
7. Do not install prior to receiving manufacturer onsite training.

D. Dowel Embedment Depth: Install to depth and spacings shown.

+++ **END OF SECTION 03605** +++

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 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

1.02 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.

1.03 QUALITY ASSURANCE

Reference Standards: Comply with the current provisions of the following, except as otherwise indicated:

1. AISC "Code of Standard Practice for Steel Buildings and Bridges"
2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" and including the "Commentary of the AISC Specification"
3. 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
4. AWS Structural Welding Code AWS D1.1-90 and "Standard Qualification Procedure"
5. ASTM A 36-61, Structural Steel (Rev. A)
6. ASTM A 53-83, Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless
7. ASTM A 325-83, High Strength Bolts for Structural Steel Joints (Rev. C) (*A325M-83)
8. ASTM A 490-83, Heat-Treated Steel Structural bolts, 150 ksi Minimum Tensile Strength (Rev. A) (*A490M-82)

9. ASTM A 500-82, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes (Rev. A)
10. ASTM A 501-83, Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
11. AWS D1.1-90 (83), Structural Welding Code - Steel

1.04 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.

1.05 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 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

3.01 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.

3.02 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.

3.03 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. Grout prior to placing loads on structure.

3.04 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.

3.05 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.

3.06 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.

3.07 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.

3.08 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.

3.09 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 - Finishes.

+++ END OF SECTION 05120 +++

SECTION 05500
MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 SCOPE

A. 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:

1. Anchors or anchor bolts except those specified to be furnished with all equipment.
2. Vault Door.
3. Watertight Doors.
4. Plates and angles for grates.
5. Stainless steel doors and safety gates.

B. Related Work Specified Elsewhere

1. Section 05120, Structural Steel.
2. Anchor bolts for equipment are included in the respective Sections of Divisions 13, and 15.
3. Pipe hangers, supports and concrete inserts are included under Division 15.
4. Cast iron manholes, fences and guard rail are included under Division 2.

1.02 SUBMITTALS

A. Manufacturers data on all materials listed in Part 2 of this Section.

B. Detail drawings, as provided for in the General Conditions, showing sizes of members, method of assembly, anchorage, and connection other members shall be submitted to the Engineer for review before fabrication. Drawings shall include vault and watertight door test results.

C. Watertight door test results.

1.03 QUALITY ASSURANCE

Reference Standards: Unless otherwise specified, materials shall conform to the following:

Life Safety Code	NFPA 1010
Structural Steel ASTM A36	
Welded and Seamless Steel Pipe	ASTM A53
Gray Iron Castings	ASTM A48, Class 30
Galvanizing, general	ASTM A123
Galvanizing, hardware	ASTM A153
Galvanizing, assemblies	ASTM A386
Aluminum (Extruded Shapes)	6063 T5 (Al urn. alloy)
Aluminum (Extruded Pipe)	6063 T6 (Al urn. alloy)
Aluminum Sheet and Plate	6061 T6 (Alum. alloy)
Bolts and Nuts ASTM A3O7	
Stainless Steel Bolts, Bars & Shapes	ASTM A276
Stainless Steel Plate and sheet	ASTM A167
Welding Rods for Steel	AWS Spec. for Arc Welding

1.04 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections. 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.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

1.05 FIELD MEASUREMENTS

Field measurements shall be taken at the site to verify or supplement indicated dimensions and to insure proper fitting of all items.

1.06 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 ANCHORS, BOLTS, AND FASTENING DEVICES

A. Anchors, bolts, etc., shall be furnished as necessary for installation of the work of this Section.

B. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum and stainless steel shall be attached to concrete by means of stainless steel machine bolts and iron or steel shall be attached with steel machine bolts unless otherwise specifically noted.

C. For structural purposes, unless otherwise noted, expansion bolts shall be Wej-it "Ankr-Tite", Phillips Drill Co. "Wedge Anchors", or HILTI-HIT(C-100). When length of bolt is not called for on the Drawings, the length of bolt provided shall be sufficient to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete.

D. Material shall be as noted on the Drawings. If not listed, stainless steel.

2.02 ALUMINUM ITEMS

A. Vault Door

1. Vault door shall be of double cover construction in size(s) shown on the Drawings. Doors shall be aluminum 1/4" diamond pattern plate reinforced on the underside to withstand a H-20 wheel load. Channel frame shall be 1/4" aluminum with full anchor flange around the perimeter.
2. Doors shall be equipped with heavy forged brass hinges with stainless steel pins and shall pivot so cover does not protrude into the channel frame. Hinges shall be through bolted to the cover with tamper proof stainless steel lock bolts and shall be through bolted to the frame with stainless steel bolts and lock nuts. Doors shall be equipped with compression springs enclosed in telescopic tubes. Upper tube shall be the outer tube to prevent accumulation of moisture, grit and debris inside the tube assembly. Lower tube shall interlock with a flanged support shoe fastened to a formed 1/4" gusset support plate.
3. Doors shall be fitted with the required number and size of compression spring operators to afford ease of operation through the entire arc of opening and to act as a check in retarding downward motion when being closed. Doors shall be equipped with a hold-open arm which automatically locks the door in the open position. A conveniently located handle shall release the door(s) for closing.
4. A stainless steel snap lock with a fixed turn handle shall be mounted on the underside of the door. A removable exterior latch shall be provided and the latch release shall be protected by a flush gasketed removable screw plug. Doors shall have a lift handle that is designed to be flush with the walking surface when not in use. A 1-1/2" drain coupling shall be located in the front right corner of the channel frame. Hardware shall be #316 stainless steel.
5. Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of frame. Installation shall be in accordance with manufacturer's instructions and manufacturer shall guarantee satisfactory operation. Manufacturer shall guarantee against defects in material or workmanship for a period of five years.
6. Vault door shall be Type JD as manufactured by the Bilco Company, New Haven, Connecticut or equal.

B. Watertight Door

1. Watertight door shall provide an effective seal against the maximum flood level to top of door. The door shall be 4' x 8' with square corners and the pressure on the door shall be transmitted to the frame and/or dogs.
2. Structural plates and shapes shall be 304 stainless steel.
3. The heavy duty compression joint shall be low maintenance durometer neoprene, molded rather than extruded, with fully molded corners. Mitered joints not allowed.
4. Hinges shall include stainless steel hinge pins, grade 5 or better mounting bolts and slotted hinge blades. The lower hinge shall have a bronze oil-impregnated thrust bearing.
5. The door latch system shall be operated with minimum effort and time by turning of the handhweel from either side. The handwheel shall actuate a minimum of six dogs each of which shall be adjustable for stroke length and position for optimum seal compression.
6. The edge coming contacting the door gasket shall be machined, rather than rolled, to maximize sealing.
7. Door manufacturer shall factory test the finished assembly to verify that the door will withstand the design hydrostatic pressure. test results shall be submitted to the Engineer prior to door installation.
8. Watertight door shall be model D3BQA as manufactured by The Presray Corporation, Pawling, New York or equal.

C. 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 or the plans within the tolerances published by the American Aluminum Association.

2.03 STEEL ITEMS

A. All miscellaneous lintels and closures not shown on the Drawings shall be galvanized steel and shall be provided as a part of this Section.

Provide galvanized loose steel lintels for openings and recesses in masonry walls as shown. Weld adjoining members together to form a single unit where indicated. Provide not less than 8" bearing at each side of openings unless otherwise indicated.

B. Miscellaneous steel shall be fabricated and installed in accordance with the Drawings and shall include: beams, angles, support brackets, splice plates, anchor bolts (except for equipment furnished in Divisions 13 and 15); 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 A-167 and ASTM A-276:

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.

PART 3 - EXECUTION

3.01 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 smooth, free from scale, lumps, blisters, sand holes, and defects of any kind which render them unfit for the service for which they are intended. 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 surfaces. 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 0 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. Final painting is specified in Section 09900, Painting.

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

3.02 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 manufacturers 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.

C. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to dissimilar metal.

D. Where aluminum contacts concrete, apply a heavy coat of approved alkali resistant paint to the concrete.

+++ END OF SECTION 05500 +++

SECTION 07900
CAULKING AND SEALANTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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.

1.02 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.

1.03 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.

1.04 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.

1.05 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 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.

1.07 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

2.01 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. 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

3.01 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.

3.02 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.

3.03 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 07900 +++

SECTION 09900
PAINTING

PART 1 - GENERAL

1.01 SCOPE

A. This Section of the Specifications includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the Work.

B. Section includes:

1. Surface preparation to receive finishes.
2. 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.

1.02 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.

1.03 SUBMITTALS

All submittals and storage and protection provisions shall be in accordance with the requirements of the General Conditions, and the following.

1. Product data:
   a. Submit complete list of products for use; indicate compliance with:
      1) Mercury-free composition limits.
      2) VOC limits, when mixed and thinned.
      3) Indicate lead content.
   b. Indicate manufacturer, brand name, quality, and type paint for each surface to be finished; correlate to specified item if from other manufacturer than specified item. Refer to the attached sample Paint Submittal Schedule for required submittal

format.

c. Include specified manufacturer's data sheets for reference to submitted manufacturer's data sheets.
d. Manufacturer's Safety Data Sheets (MSDS) for materials.
e. Intent of Contractor to use products specified does not relieve him from responsibility of submitting product line.

2. Samples:
   a. Color samples: Submit two sets of color samples from paint manufacturers proposed for use for color selections by Engineer.
   b. Brush-outs:
      1) Prepare actual brush-outs for each color paint, stain, or finish following final color schedule issuance.
      2) Submit brush-outs in duplicate: minimum size, 120 sq. in.
      3) Apply products in number of coats specified for actual Work.
      4) Provide following substrates for brush-outs:
         a) Concrete unit masonry: Paint one face to simulate concrete and masonry.
         b) Hardboard to simulate drywall, lumber, board products, and metals for paint finish.
         c) Actual species and grade of wood specified for transparent finish.

3. Quality control submittals:
   Certificates:
   1) Indicate interior paints and stains are mercury-free.
   2) Indicate lead content. Lead content in excess of 0.06% by weight of nonvolatile content calculated as lead metal is prohibited.
   3) Indicate compliance with applicable VOC limits when mixed and thinned.

1.04 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.

1.05 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.

1. Unpainted Products: Full field cleaning and priming will be performed in accordance with specification requirements for unpainted products. Maintain adequate equipment on the site to assure proper cleaning.
2. Shop Primed Products:
   a. Manufactured products may be shop cleaned and primed. Shop cleaning must equal or exceed cleaning specified in the Painting Schedule. Clean as specified

and reprime all abrasions, weld splatter, excessive weathering, and other defects in the shop prime coating.

b. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.

c. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong primer was applied, that the primer was applied improperly, or has excessively weathered, or the product is otherwise unacceptable.

3. Finish Painted Products:
Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered, or not of the selected color, repaint as necessary in accordance with the paint system manufacturer's written recommendations.

4. Hardware:
Remove all electrical plates, surface hardware, fittings and fastenings prior to painting operations. These items are to be carefully stored, cleaned and replaced upon completion of Work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.06 SEQUENCING AND SCHEDULING

A. Schedule and coordinate this Work with other trades; proceeding until other Work and job conditions are proper to achieve satisfactory results is prohibited.

B. Examine specification sections for various other trades; be thoroughly familiar with Work required in other sections regarding painting.

PART 2 - PRODUCTS

2.01 MATERIAL SCHEDULE

Material schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

2.02 APPLICATION DATA

All applicable data currently published by the paint manufacturer relating to

surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It will be the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.

2.03 MATERIALS

A. Paints shall be factory mixed and delivered to the job in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer's instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.

B. Unless otherwise specified, paints shall be of the best grade. All thinners, driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.

C. Paint thinners and tints: Products of same manufacturer as paints or approved by paint manufacturer for use with paint.

D. Shellac, turpentine, patching compounds, and similar materials required for execution of Work: Pure, best quality products.

2.04 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 exposed pipes in colors consistent with City standards.

PART 3 - EXECUTION

3.01 GENERAL

A. Adequately protect other surfaces from paint and damage. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.

B. Protection: Cover finished Work of other trades, surfaces not being painted concurrently, and prefinished items.

C. Application of materials in spaces where dust is being generated is prohibited.

3.02 PRODUCT HANDLING

A. Delivery

1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.
2. Each container shall be clearly marked or labeled to show paint identification, paint type and color, date of manufacture, batch number, analysis or contents, identification of all toxic substances, and special instructions.

B. Storage

1. Store only acceptable project materials on the project site.
2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable federal, state and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.
3. Restrict storage area to paint materials and related equipment.
4. Place any materials which may constitute a fire hazard in closed metal containers and remove daily from the project site.
5. Maintain neat, clean conditions in storage area; remove used rags from work areas at end of each day's work; store rags in closed containers.
6. Close containers at end of each day's Work. Leave no materials open.
7. Safety precautions:
   a. Provide temporary fire protection equipment in materials storage area. Mark fire protection equipment location for quick access.
   b. Prohibit smoking in storage area; post signs in visible location adjacent to and within storage area.

3.03 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.

3.04 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.

3.05 SURFACE PREPARATION

A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease or dust. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in weld ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.

B. Lumber, plywood, and veneered surfaces:

1. Apply shellac, maximum four lb. cut to knots, pitch, and resinous sapwood prior to application of first paint coat.
2. Surfaces to be painted: Fill nail holes, cracks, joints, and defects with spackling compound. Apply after first coat of paint.
3. Sand surfaces smooth, except where rough-sawn surfaces are indicated. Dust to remove debris.
4. Treat mildewed surfaces with solution of one quart hypochlorite bleach, one tablespoon laundry detergent, and three quarts water. Rinse and allow to dry prior to painting.
5. Previously painted surfaces: Remove dirt, debris, and chalking by washing with detergent and water or low pressure cold water spray. Dull glossy surfaces by light sanding. Remove loose paint and blisters by scraping and sanding.

C. Gypsum board:

1. Fill narrow, shallow cracks and small holes with patching plaster or non-shrinking spackling compound. Allow to dry; sand smooth without raising gypsum board paper nap.
2. Wall surfaces designated to receive semi-gloss or gloss finish: Roll apply batter consistency mixture of gypsum board joint compound and water to surfaces; remove immediately with wide broadknife, without leaving ridges or gouges in finished surface. Allow to dry prior to prime coat application, Or; apply U.S. Gypsum Company, Sheetrock First Coat at 300-500 SF per gallon in accord with manufacturer's installation instructions. Allow to dry prior to prime coat application.

D. Ferrous Metals: Standards for the surface preparation of ferrous metals required in the Material Schedules are the standards of the Steel Structures Painting Council (SSPC, SP-1 through SP-10). Inspection of these surfaces will be evaluated by field comparison with visual comparator panels. These panels shall be securely wrapped in clear plastic and sealed to protect them from deterioration

and marring.

E. Galvanized metal: Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

F. Aluminum: Sand to remove oxides. Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

G. 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.

3.06 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.

3.07 PAINTING SCHEDULE (Customize for specific project)

A. Paint construction on roof top; include mechanical and electrical equipment except as indicated below.

1. Fume hood exhaust fan enclosures on roof.
2. Solvent Room exhaust fan.
3. HPLC Room exhaust fans.

B. Surfaces not requiring painting:
1. Face brick.
2. Precast concrete.
3. EIFS.
4. Prefinished surfaces and items.

5. Concealed ductwork, conduit, and piping.
6. Fume hood exhaust fan enclosures on roof.
7. Solvent Room exhaust fan on roof.
8. HPLC room exhaust fans on roof.

C. The Painting Schedule summarizes the painting systems to be applied to the various surfaces.

SAMPLE PAINT SUBMITTAL SCHEDULE **(Customize for specific project)**

System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
A	SS 3300-2.05	Epoxy Floor Sealer	Blastrac or Muriatic Etch	76 Series, 4-6.0 mils	2 Coats of 76 Series, 4-6.0 mils	Gray
B	SS 3300-2.06	Tnemec 61 Submitted	SSPC-7	Self Priming	2 Coats of Tnemec 61,4-6.0 mils per coat	Gray
C	SS 4400	Masonry Paint	SSPC 2 or 3 Pressure Washing to Remove Loose Concrete & Dirt	Block Fil 46-W-8,1 Coat	2 Coats of Valspar 76 Series at 4-6.0 mils per coat	Gray
D	SS 5500	Misc. Metals	SSPC 6 for Non-Immersion	Tnemec 90-97	2 Coats of 89 Series for Non-Immersion at 4-6.0 mils	Warm Gray M3759
D	SS 15000	Dip Pipe	SSPC 6 for Non-Immersion	Tnemec 90-97	2 Coats of 89 Series for Non-Immersion at 4-6.0 mils	Buff D4608
E	SS 15000	Dip Pipe	SSPC 10 for Immersion	Not Required	2 Coats of 78 Series for Immersion at 4-6.0 mils	Gray
I	SS 15060	Plastic Pipe	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	Warm Gray M3759
I	SS 15060	Valves & Operator	Lightly Sand	Not Required	2 Coats of 89 Series, 4-6.0 mils per coat	OSHA Orange

PAINTING SCHEDULE

Surfaces	Substrate Materials	Paint Material/Schedule
Ductile Iron Pipe (Above Grade)	Ductile Iron	141
Interior Structural Steel	Galvanized Metal	140
	Ferrous Metal	140
All Other Listed Metal Surfaces	Galvanized Metal	141
	Ferrous Metal	141

MATERIAL SCHEDULE 131

TYPE: EPOXY

USE: INTERIOR MASONRY AND CONCRETE

SURFACE PREPARATION: CC-I

TNEMEC

FIRST COAT: EPOXY-POLYMIDE FILLER

SECOND COAT: SERIES 66 HI-BUILD EPOXOLINE - 4.0 MILS DRY

THIRD COAT: SERIES 66 HI-BUILD EPOXOLINE - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

KOPPERS

FIRST COAT: CONCRETE AND MASONRY FILLER

SECOND COAT: HI-GARD EPOXY - 4.0 MILS DRY

THIRD COAT: HI-GARD EPOXY - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Sherwin-Williams Company.

MATERIAL SCHEDULE 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: CHEM-PRIME 37-77 - 2.5 MILS*

FIRST COAT: SERIES 69 EPOXOLINE II - 6.0 - 8.0 MILS*

SECOND COAT: SERIES 69 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 90-97 TNEME-ZINC 2.5-3.5 MILS DRY

SECOND COAT: SERIES 66 HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

THIRD COAT: SERIES 66 HI-BUILD EPOXOLINE 4.0-6.0 MILS DRY

* MINIMUM TOTAL DRY FILM THICKNESS 10.5 MILS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN THE NUMBER OF COATS SHOWN, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Koppers.
b. Sherwin-Williams Company.

MATERIAL SCHEDULE 150

TYPE: ACRYLIC LATEX

USE: ALL PVC SURFACES TO BE PAINTED, AS SPECIFIED OR SHOWN ON DRAWINGS.

SURFACE PREPARATION: CLEAN AND DRY.

GLIDDEN

FIRST COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

SECOND COAT: GLID-GUARD LIFEMASTER NO. 6900 SERIES - 2.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 4.0 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

    a. Benjamin Moore Company.
    b. Devoe and Reynolds Company, Inc.
    c. Pratt and Lambert Inc.
    d. PPG Industries Inc.
    e. Sherwin-Williams.

+ + + END OF SECTION 09900 + + +

SECTION 13000
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM
GENERAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 SCOPE

A. The Instrumentation, Control, and Monitoring System (ICM) consists of modification of existing panels, field components, and system communication links.

B. This Section covers the general requirements for furnishing and installing all instrumentation, control and monitoring (ICM) systems complete in every detail for the purposes specified and shall form a part of all other Sections of Division 13 unless otherwise specified. Other Sections of this Division shall supplement this Section as necessary.

1. Work Included:
    a) 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.
    b) Provide all the necessary equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to insure that the City receives a completely integrated and operational ICM as herein specified.
2. Work Not Included:
    a) Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, and miscellaneous mechanical work as specified in other Divisions.
    b) 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.

C. System Responsibility

1. Each Section in this Division shall be provided by a competent, qualified company with two years minimum experience successfully performing similar work of a similar scope. System installation, including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have two years minimum experience successfully performing similar installations. The System shall be integrated using the latest, most modern proven design.

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 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.

D. Contract Drawings

Information on the Drawings

The following information relative to the work of this Division is indicated on the Contract Drawings.

a. Location of all primary elements, cabinets, and final control elements.
b. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
c. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Contractor.
d. Major instrument conduit runs.

1.02 SUBMITTALS

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

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-inch by 17-inch 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. 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

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:

Facility identification (Name, location, etc.)
Loop identification (Name or function)
Equipment tag and serial numbers.
Scale Ranges and units.
Test mode or type of test.
Input values or settings.
Expected outputs and tolerances
Actual readings at 10, 50, and 90 percent of span.
Explanations or special notes as applicable.
Date, time, and weather.
Tester's certification with name and signature.

2. 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:
Specification page and paragraph of function demonstrated
Description of Function
Test procedure description
Space after each specific test to facilitate signoff on completion of each test.

1.03 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.

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 including 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.

a. Certified Functional testing Report countersigned by the Engineer.
b. Final Documentation.
c. Spares and expendables delivery.
d. Training.

1.04 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:

a. 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:

Instrument, panel, rack or device tag number
Description
Quantity supplied
Reference to component data sheet and/or catalog cut
Component type

b. Component Data Sheets

See 1.02 B.2 specified herein before.

c. Catalog Cuts

See 1.02 B.1 specified herein before.

d. 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:

Operating procedures
Installation procedures

Maintenance procedures
Troubleshooting procedures
Calibration procedures
Internal device schematics and wiring diagrams
Shut-down procedures
Component parts list
Detailed circuit operational description including programmable controller ladder diagrams.

e. 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.

f. "As-Shipped" Drawings

Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:

Panel Fabrication Drawings.
Panel Wiring, Loop, and Interconnection Drawings.

1.05 FINAL "AS-INSTALLED" DOCUMENTATION

A. Reproducible Drawings

1. Contractor shall submit one (1) set of reproducible's 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 1.02 C.7 specified herein before.

3. Panel Fabrication and Wiring diagrams

See 1.02 C.4 and 1.02 C.5 specified herein before.

4. Interconnecting Wiring Diagrams

See 1.02 C.6 specified herein before.

5. Instrument Installation Details

See 1.02 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:

a. Project Name
b. Volume Number
c. Software Program Name and Version used to generate the files.
d. Labeled "AS-INSTALLED"

1.06 TRAINING REQUIREMENTS

A. General

1. 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.

2. Duration

Training specific to the system hardware. This training shall be for a minimum time period of two (2) days, one day of which may be performed during the operational testing period.

C. 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:

a. Dissolved Oxygen Element and Transmitter.
b. Flow Element and Transmitter, Electromagnetic.
c. Flow Element and Thermal Transmitter, Thermal.
d. Level Element and Transmitter, Ultrsonic.

1.07 POST-CONTRACT SYSTEM SUPPORT

Maintenance Contract

1. Duration

Provide a 1 year maintenance contract for all components furnished.

2. 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.

1.08 GUARANTEE AND WARRANTEES

Guarantee all work of Division 13 in accordance with the Conditions of Contract and Division 1. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to Engineer with City named as beneficiary.

PART 2 - PRODUCTS

2.01 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 Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities; 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 13200, General Requirements for Process Instrumentation Systems.
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: 0^{o}C to $+50^{o}$C
      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: -15^{o}C to $+50^{o}$C
      Ambient Relative Humidity: 5% to 80%
   c. Indoor Environmentally Controlled Areas:
      Ambient Temperature: -0^{o}C to $+50^{o}$C
      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.

+++ END OF SECTION 13000 +++

SECTION 13200
GENERAL REQUIREMENTS FOR
PROCESS INSTRUMENTATION SYSTEMS

PART 1 - GENERAL

1.01 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.

1.02 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 13000, Instrumentation, Control, and Monitoring System General and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

Data sheets for all instruments and accessories to be provided. Data sheets shall be in accordance with ISA S20. All applicable entries on the data sheet shall be completed.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements

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 13000, Instrumentation, Control, and Monitoring System General Requirements. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000, Instrumentation, Control, and Monitoring System General Requirements-1.03.

PART 2 - PRODUCTS

2.01 INSTRUMENT SCHEDULE

A. The instrument schedule, paragraph 3.03 of this section, lists major instruments required to provide the process instrumentation system. 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.

B. In some cases, it is possible to combine the functions of two or more instruments specified in the Instrument Schedule into a single instrument. Functions which may be ordinarily combined into a single instrument are multiple alarms derived from a common transmission signal, and signal linearization may be combined into transmitters except where the nonlinear signal is used for specific purposes such as standardized flow calculations. Flow computers may be used in lieu of individual function modules for standardized flow calculations providing equivalent performance is provided. Alarm or safety functions shall be derived directly from process measurements and shall not be derived from transmission signals unless specifically shown. Alarm or safety functions shall not be combined into any instrument used for process control, indication, recording, or any combination thereof unless specifically shown.

C. Standard instruments shall be modified as necessary to meet the specified application requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

Installation shall be in accordance with Section 13000, Instrumentation, Control, and Monitoring System General Requirements and this section, subsequent sections of this division, and as shown on the drawings.

B. Electrical Power Wiring:

Electrical power wiring shall be in accordance with paragraph 13000, Instrumentation, Control, and Monitoring System General Requirements-3.01.

C. Signal Wiring:

Signal wiring shall be in accordance with paragraph 13000 Instrumentation, Control, and Monitoring System General Requirements-3.01.

D. Process Connections:

. Process connections shall be in accordance with paragraph 13211, Transmitters-3.01.

E. Tubing:

Tubing shall be installed in accordance with paragraph 13211, Transmitters-3.01.

F. 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).

3.02 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 13000, Instrumentation, Control, and Monitoring System General Requirements and this section. Testing shall be performed in accordance with Section 13000, Instrumentation, Control, and Monitoring System Requirements, this section, and subsequent sections of this division.

B. Installed Tests and Inspection:

1. Test Reports: Test reports shall conform to the requirements of reference forms 13000-A through 13000-K included in paragraph 3.02C of this Section.
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 01600
Individual components	Section 01600
Individual loops	Section 01600
Loop commissioning	Section 01600

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.

3.03 INSTRUMENT SCHEDULE

A. General:

The following is a schedule of instrumentation equipment and devices to be provided as part of this Contract as described in paragraph 1.01 of this section.

B. Clarification:

1. Loop Number: The loop number appears as a sub-heading and consists of an area number, a one-letter prefix, indicating the loop function, followed by a number identifying that particular loop (see Drawing P1). In addition, a functional

description of the loop is given. The loop number is followed by a list of the individual devices which are part of the loop. Example: ** 10-F-0101 PLANT INFLUENT FLOW.

2. Instrument Number: The instrument number consists of a unique alpha-numeric identifier for each instrument or device (see Drawing P1).
3. Location Reference: Lists the electrical plan drawing which best indicates the location of instruments which are not mounted in process lines or in panels. In the case of panel mounted instruments, the number of the appropriate panel is given.
4. Specification Reference: Lists the area of the Specifications which specifies the particular item listed.
5. P&I Diagram: Lists the piping and instrumentation diagram number on which the instrument is shown.
6. Control Diagram: Lists the control diagram and drawing number on which the instrument is shown.
7. Mechanical Reference: Lists the mechanical drawing which best indicates the location of instruments which are mounted in process lines.
8. Notes: Specifies set points, ranges, scales, etc., as required. Provides modifying specifications or requirements for individual instruments or general information required.

C. Instrument List (The following list is preliminary and does not represent all required instruments.):

Instrument	Location
Electromagnetic Flow Meter (36” Dia.)	Discharge Manifold (North)
Electromagnetic Flow Meter (36” Dia.)	Discharge Manifold (South)

+++ END OF SECTION 13200 +++

SECTION 13212
TRANSMITTERS

PART 1 - GENERAL

1.01 SCOPE

Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of process variable transmitters which form a part of the process control systems specified in Section 13200, General Requirements for Process Instrumentation 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. Application requirements are specified in the instrument schedule, paragraph 13200-3.03.

1.02 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 13000, Instrumentation, Control, and Monitoring System General Requirements and this section shall be submitted. All required information for this section shall be included in one complete submittal. In addition, the following specific information shall be provided:

In accordance with paragraph 13000-1.04 F, record documentation shall include the data sheets specified in paragraph 13200-1.04 B.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.

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 13000, Instrumentation, Control, and Monitoring System General Requirements. They are a part of this section as specified and modified.

1.04 ENVIRONMENTAL CONDITIONS

Equipment provided under this section shall be suitable for operation under ambient conditions described in paragraph 13000-1.03.

PART 2 - PRODUCTS

2.01 GENERAL

Unless otherwise specified, measuring elements and transmitters shall comply with the following requirements:

1. Output indicators complying with paragraph 2.02 of this section shall be provided with any transmitter that does not include an integral process variable indicator.
2. Transmitters shall be two-wire type with operating power derived from the signal transmission circuit.
3. Transmitter output shall be 4 to 20 milliamperes, current regulated and shall drive any load between 0 and 550 ohms with the power supply at 23 volts DC.
4. Transmitters shall meet specified performance requirements with load variations within the range of 0 to 600 ohms with the power supply at 24 volts DC.
5. Transmitter output shall be galvanically isolated.
6. Time constant of transmitters used for flow or pressure measurement, including level transmitters used for flow measurement, shall be adjustable from 0.5 to 5.0 seconds.
7. Transmitter output shall increase with increasing measurement.
8. Transmitter enclosures shall be rated NEMA 250, Type 4, unless otherwise specified.
9. Transmitters located outdoors shall be provided with surge protectors: Rosemount Model 470A, Taylor 1020FP, or equal.
10. Transmitters located in Class 1, Division 1 and 2 areas shall be made safe by suitable intrinsic safety barriers as specified in paragraph 2.03 of this section.

2.02 OUTPUT INDICATORS

A. Integral:

When available, transmitters shall be provided with integral output indicators. Indicators shall be shall be 2-½ inch, 90-degree movement or LCD milliammeters. Output indicators connect into the transmission circuit by means of banana jacks, and a permanently connected diode shall be provided to bypass the jacks if the meter is removed. Error shall not exceed ±2 percent of span.

B. Separate:

If output indicators for integral mounting in the transmitters is not available, a separate indicator shall be provided. Separate output indicators shall be installed in the conduit immediately adjacent to the transmitter. Indicators shall be loop-powered, two-wire, 3-½ digit, 7-segment, 0.8-inch high liquid crystal display milliammeters. The enclosure shall be rated Nema 4X, suitable for outdoor mounting. The enclosure shall be suitable for in-line conduit mounting, unless otherwise specified. The indicator shall be suitable for operation within a temperature range of -15 to + 150 degrees F. Accuracy shall be ± 0.1 percent of span + 1 count. Voltage drop shall not exceed 4 volts at 40 mA. A/D conversion time shall be no greater than 500 milliseconds and display update time shall be no greater than 0.5 seconds. Separate output indicators shall be Action Instruments Visipack V560 or equal.

2.03 INTRINSIC SAFETY BARRIERS

Intrinsic safety barriers for two-wire transmitters shall be of the active, isolating, loop powered type. Barrier shall be Measurement Technology LTD. type MT3042, Stahl 9005/01-252/100/00, or equal.

2.04 INSTRUMENTATION SPECIFICATION SHEETS (INSTRUSPEC)

Specific requirements for instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

PART 3 - EXECUTION

3.01 INSTALLATION

General requirements for installation of instruments specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.02 TESTING

General requirements for testing of transmitters specified in this section are listed on INSTRUSPEC sheets in paragraph 3.03 of this section.

3.03 INSTRUMENT SPECIFICATION SHEET--INSTRUSPEC

Instrument Identification	FMT
Instrument Function	Flow measurement
Instrument Description	Magnetic Flow Transmitter
Power Supply	120 Vac, 60 hertz nominal
Signal Input	Process
Signal Output	Analog signal as specified in paragraph 2.01 of this section.
Process Connection	Flange, ANSI B16.5, Class 150, raised face
Product Data	
General	Magnetic flow meter shall be provided as a system consisting of a flow tube and separate converter/transmitter complete with all necessary interconnecting cables. Converter/transmitter shall be suitable for full-scale flow rates from 3.0 to 30 feet per second. System accuracy shall be better than 0.5 percent of flow rate or 0.1 foot per second, whichever is greater. Magnetic flow meter shall be the pulsed dc type.
Flow tube	Unless otherwise specified, flow tube shall be polyurethane lined steel with type 316 stainless steel electrodes. Flow tubes shall have 150 pound ANSI flange connections except flow tubes 4-inch and smaller may be wafer type. Flow tubes located in lined or nonconductive pipes shall be provided with grounding spools or swages fabricated from ASTM A312, type 316 stainless steel. Grounding spools or swages inside diameter shall be 1/16 inch smaller than flow tube inside diameter. Where pipe run size is different from specified flow tube size, uniformly diverging swages with a total angle between walls not exceeding 15 degrees shall be provided. Excitation power requirements shall not exceed 100 volt-amperes. Flow tube shall be coated with corrosion-resistant polyurethane or epoxy paint.
Converter/ transmitter	The flow converter/transmitter shall contain all electronics associated with the magnetic flow meter system and shall be housed in a NEMA 4X enclosure suitable for wall or pipe mounting. Calibrated span adjustment shall permit range adjustment without need for separate test equipment. Adjustable dampening shall be provided. The measuring range shall be a direct digital input in gpm, and fully adjustable over a range of up to 30 fps. The converter/transmitter shall contain self diagnostics, automatic data integrity checking, and shall be completely interchangeable with other units of the same type without need for recalibration. No auxiliary test meter or primary simulator shall be required for commissioning or zeroing.The converter/transmitter shall contain the following features:

	a. Adjustable damping of analog signal. b. Low flow cutoff of pulse output. c. Integral rate of flow indicator and 7-digit LCD totalizer.
Execution	
Installation	Install in accordance with manufacturer's instructions, paragraph 13200-3.01, the recommendations of API RP550, and the specified functional requirements. Avoid damage to the tube liner. Spool pieces or swages shall be bolted to each end of the flow tube and the entire assembly slid into the pipe run as a unit. Flange bolts shall be tightened to tube manufacturer's specified torque. The converter/transmitter shall be separately located to provide convenient access for observation and maintenance but shall be as close to the flow tube as practical.
Cable	The signal cable between the primary element and the converter/transmitter shall be provided by the instrument manufacturer. A sufficient length of cable shall be provided for installation of a continuous run between the primary element and the converter/transmitter.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Foxboro, Yokogawa, Rosemount, or equal.

3.04 INSTRUMENT SPECIFICATION SHEET - INSTRUSPEC

Instrument Identification:	PGT
Instrument Function	Pressure measurement
Instrument Description	Gauge pressure transmitter
Power Supply	As specified in paragraph 2.01 of this section.
Signal Input	N/A
Signal Output	Analog transmission signal as specified in paragraph 2.01 of this section
Process Connection	½-inch female NPT flange adapters
Product Data	Pressure transmitter shall be capacitance or bonded strain-gauge type. Unless otherwise specified, wetted parts shall be ASTM A276, type 316 stainless steel. Transmitter span limits shall be selected so that the span specified in paragraph 13200-3.03 is at least 130 percent of the minimum span limit and no more than 70 percent of the maximum span limit. Transmitter range limits shall be selected so that the upper end of the range specified in paragraph 13200-3.03 does not exceed 70 percent of the upper range limit. Over-range capacity without affecting calibration shall be not less than 200 percent of maximum specified range. Volumetric displacement shall not exceed 0.01 cubic inches over the specified span. Fill fluid, unless otherwise specified, shall be silicone oil. Adjustable dampening shall be provided. External zero adjustment shall be provided. Error shall not exceed 0.25 percent of span. Electronics housing shall be rated NEMA 4X unless otherwise specified. Reference diaphragm shall be provided with a weatherproof, bug-proof atmospheric vent. Static pressure rating shall be 2000 PSIG or greater.
Execution	
Installation	Install in accordance with manufacturer's instructions, paragraph 13200-3.01, the recommendations of API RP550, and the specified functional requirements. Wherever possible pressure instruments shall be mounted below the process tap for liquid and steam service, and above the process tap for gas service. Where these configurations cannot be maintained, vapor traps or drain pots with vent or drain valves shall be provided.
Test	In accordance with paragraph 13200-3.02.
Application/Calibration	Application, calibration, and set points shall be as specified in paragraph 13200-3.03.
Approved Manufacturers	Rosemount 1151 series, Foxboro 820 series,or equal.

+ + + END OF SECTION 13212 + + +

SECTION 13300
INSTRUMENTATION, CONTROL AND MONITORING SYSTEM COMPONENTS

1.01 SCOPE

Requirements of the General and Special Conditions of the Contract, Division 1 and Section 13000, Instrumentation, Control, and Monitoring System General Requirements form a part of this Section. This Section specifies primary and secondary elements of process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these elements, to perform the required functions in conjunction with information and equipment specified in other Sections of Division 13. Schedules indicating required information are attached at the end of this Section, but shall not be construed as Bills of Material or as a complete listing of all required devices.

1.02 QUALITY ASSURANCE

A. Manufacturer

In addition to requirements of Section 13000, Instrumentation, Control, and Monitoring System General Requirements, instrumentation and control equipment shall be manufactured by a firm regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.

B. Maintainability

All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.

C. Materials and Installation

Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified.

1.03 STORAGE AND PROTECTION

Instrumentation and control components and accessories shall be stored and protected in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 FLOW, SWITCHES

A. Flow switch shall sense an adjustable preset flow rate of fluid in a pipe and operate a SPDT switch to actuate alarms or control circuits. The switch shall be rated for 1 ampere minimum load at 120 Vac, 60 Hz.

B. The flow switch shall be sized and adjusted for the pipe, fluid and flow rate or velocity shown in the Schedule. Repeatability of sensing shall be within 10 percent for any setting, and differential shall be less than +/- 40 percent within the flow range specified.

C. Set point shall be within +/- 10 percent of flow rate or velocity specified.

Liquid, Vane Type

a. Vane type liquid flow switch shall be housed in a explosion proof case, with electrical conduit connection. Switches for mounting in 1-1/2" pipe or larger shall be fitted for NPT thread mounting directly in the pipe. Smaller sizes shall be supplied mounted on a pipe fitting with female NPT threads.
b. The switch assembly shall be isolated from the flow by a diaphragm or suitable seal. The actuator vane and other wetted parts shall be stainless steel, monel, brass, or other corrosion resistant material suitable for the fluid in the pipe.
c. Vane type switches shall be as manufactured by ITT McDonnel & Miller Model FS7-4E, Magnetrol, or equal.

2.02 PROPELLER METERS

A. The propeller shall be constructed of rigid plastic that will not flex or otherwise change in dimension under maximum fluid velocity through the meter. Meters shall be in-line type of cast iron or steel, neoprene or epoxy lined. Each propeller meter shall register flow to a guaranteed accuracy of plus or minus 2 percent throughout the maximum to minimum flow ranges listed in the attached schedule.

B. Meters shall be manufactured to comply with all applicable requirements of AWWA C704. All meters shall mate with 150-pound flanges unless otherwise shown on the Drawings. Straightening vanes shall be furnished and installed upstream of the meter according to the manufacturer's recommendations. The impeller shaft, bearing spacers and seal sleeve, shall be Type 316 stainless steel. Ball bearings shall be Type 440 C with all stainless steel balls, race, and retainers. The thrust bearing, carbide pad and point, shall have Rockwell hardness of C 90 or better.

C. The meter shall be equipped with a transmitter which will generate a 4-20mA dc signal proportional to a flow of zero to the maximum flow and optionally a scaled pulse rate. A pulse rate to current converter may be used to generate the 4-20 mA dc signal. The unit shall be a two wire device powered from the receiving devices specified elsewhere herein.

D. Propeller meters shall be as manufactured by Sparling, McCrometer, Brooks, Rockwell or equal.

2.03 FLOW METER, ELECTROMAGNETIC

A. Flow element shall be of the electromagnetic type. The flow measuring system shall consist of flow element, transmitter, and appurtenances. Overall accuracy shall be plus or minus 1 percent of full scale for all flows resulting from pipe velocities of 3 to 31 feet per second. System shall operate on 120V, 60-Hz power. Power consumption shall not exceed 15 watts. Sufficient signal and power cable shall be provided for connection to the remote transmitter.

B. Flow element shall be watertight, NEMA 4 construction, FM certified suitable for Class I, Division I, Groups C and D, hazardous areas without the use of external purge systems. Unit shall be flangeless in design for mounting between ANSI Class 150 flanges. Liner material shall be Tefzel with Tantalum or equal electrodes suitable for the process medium being measured. Grounding rings shall be provided and constructed of Hastelloy "C" material.

C. Transmitter shall be remotely located in a non-hazardous area and shall include an integral LCD flow indicator. Transmitter shall be suitable for wall mounting. Output shall be a 4-20 mAdc linear signal proportional to flow capable of driving external loads up to 650 ohms.

D. Flow element and transmitter shall be Fischer & Porter Co., "Minimag" Series 10D1475 or equal.

2.04 SELECTOR, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight, industrial type selector switches with contacts rated for 120V ac service at 10 amperes continuous. The switches shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, black field, legend plates with white markings. Operators shall be black knob type. Units shall have the number of positions and contact arrangements shown. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.05 PUSHBUTTON, MOMENTARY, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight/oiltight, 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 be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have standard size, legend plates with black field and white markings. Button color shall be as required. Units shall have the contact arrangements as required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.06 INDICATING LIGHTS, WATERTIGHT, NEMA 4X

A. Units shall be heavy duty, watertight, push-to-test, industrial type with integral transformer for 120V ac applications, and full voltage type for 24V dc applications. The lights shall be rated for NEMA 4X watertight, corrosion-resistant service. Units shall be used on all outdoor and non-conditioned area enclosures unless otherwise specified. Units shall have factory engraved standard size, black field, legend plates with white markings. Units shall have screwed on prismatic lenses in colors as shown. When a common lamp test function is specified, the push-to-test feature will not be required. Units shall be single hole mounting, accommodating panel thicknesses from 1/16-inch minimum to 1/4-inch maximum.

B. Units shall be Allen Bradley, Type 800H; Square D, Type SK; or equal.

2.07 MISCELLANEOUS MECHANICAL

A. Solenoid Valves: Solenoid valves shall be packless construction two-way, three-way or four-way as required, and shall be correctly sized for the application. They shall be for normally energized or deenergized operation as required. Valve bodies shall be forged brass unless otherwise recommended by the manufacturer for a particular application. The solenoids shall be rated for continuous operation at 110 percent of rated voltage. They shall be 120VAC, 60 Hz operated. All coils shall be housed in NEMA 4 cases with provision for 1/2-in. electrical conduit Solenoid valves shall be as manufactured by ASCO, Skinner, Magnetrol, or equal.

B. Pressure Control Valves (Self Contained)

Pressure control valves of the spring loaded self contained type shall be provided as shown on the Drawings and/or specified herein. The valves shall be for regulating back pressure or discharge pressure as shown on the drawings. Wetted materials shall be entirely suitable for the process fluid as shown in the Schedule. The body shall be bronze or steel unless specified otherwise. The valves shall be sized in accordance with the required flow rate, pressure differential, inlet or outlet pressure range as shown in the Schedule. The pressure control valves shall be as manufactured by Fischer Controls, GA Industries or equal.

C. Limit Switches shall be provided to sense limiting positions of equipment such as valves, as shown on the Drawings and/or specified in the schedules. The limit switches shall be

SPDT or DPDT as required for the specified operations or as scheduled herein. The switches shall be rated for 5 amperes minimum at 120 Vac and shall be enclosed in a NEMA 4 housing unless explosion proof (XP) is specified in the schedule. Provision shall be made for 1/2" electrical conduit connection. The switches shall incorporate actuators and mounting brackets which are fabricated appropriately for the mechanical equipment being monitored. Switches shall be as manufactured by Microswitch or equal.

2.08 PRESSURE AND VACUUM GAUGES

A. Units shall be bellows or Bourdon tube actuated pressure gauges. Gauges shall be stem mounting with 4-I/2-inch dial size, unless otherwise noted. Scale range shall be as noted and accuracy shall be plus or minus 1/2 percent of span.

B. The sensing element material shall be phosphor-bronze, unless otherwise noted.

C. For unit ranges below 10 psi, units shall be bellows actuated and shall be Ashcroft "General Service Series 1180", Robert Shaw "Acragage", or equal.

D. For unit ranges above 10 psi, units shall be Bourdon tube actuated and shall be Ashcroft "Duragauge", Robert Shaw "Acragage" or equal.

2.09 PRESSURE SWITCHES

A. General. Pressure switches shall sense gauge pressure and incorporate bourdon tubes, diaphragms, or bellows as the sensing and actuating element.

B. Construction. The actuating element shall be 316 stainless steel. The actuating point shall be readily field adjustable in the range specified, and shall be of the adjustable differential (dead band) type. Switches shall be SPDT, rated at 10 amperes minimum at 120 vac. Enclosures shall be suitable for NEMA 7 & 9 explosion-proof (XP) applications. Process connection shall be 1/4-inch NPT.

C. Manufacturers. The pressure switches shall be as manufactured by Mercoid, United Electric, ASCO, or equal.

2.10 INDICATOR, FIELD MOUNTING

A. Indicators shall be suitable for wall mounting in a Class I, Division I, Groups D hazardous location. The unit shall receive a 4-20 mA dc analog signal proportional to a process variable on a mirrored 4-inch minimum scale. Scale range shall be as noted. Indication accuracy shall be plus or minus 2 percent of span. Input impedance shall be less than 50 ohms.

B. Indicator housing shall be NEMA4 unless otherwise noted with a gasketed viewing window or door. Unit shall be similar to Transmation Model IS210M; or equal.

2.11 ROTAMETERS

Rotameters shall have boro-silicate glass tubes and stainless steel floats. The body may be anodized aluminum or stainless steel. End fittings shall be stainless steel and selected to suit the application. O-rings shall be Viton and tube shield shall be clear plastic. The meter scale shall be linear and direct reading in gph or ccpm. Scale length shall be 5 inches minimum. Furnish needle valves on rotometers for adjustment of flow. The size and capacity shall be as shown on the Drawings or as recommended by the pump manufacturer, but not less than 10 gph. Rotometers shall be as manufactured bv F&P, Brooks Instrument or equal.

+++ END OF SECTION 13300 +++

SECTION 15056
PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping ½ in. and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports ½ in. and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

   The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified in paragraph 2.03 J.

E. Design and provide all temporary pipe supports required during installation and testing.

1.02 RELATED WORK

A. Division 1: General Requirements

B. Section 03300: Cast-in-Place Concrete

C. Section 09900: Painting

D. Section 15060: Piping and Appurtenances and Fittings

E. Section 15100: Valves

F. Section 15410: Plumbing

G. Section 15891: Ductwork

1.03 REFERENCES

A. American Institute of Steel Construction (AISC) Manual of Steel Construction.

B. American Society for Testing and Materials (ASTM) Publications:

1. A36: Specification for Structural Steel.
2. A500: Cold formed welded and seamless carbon steel structural tubing.
3. E165: Practice for Liquid Penetrant Inspection Method.
4. E709: Practice for Magnetic Particle Examination.
5. A307: Specification for Carbon Steel Bolts and studs, 60,000 psi Tensile.
6. A312: Seamless and welded austenic stainless steel pipe.
7. A572: Specification for Steel Plate.

C. American National Standards Institute (ANSI):

ASME/ANSI B31.1: Power Piping Code.

D. American Welding Society (AWS) Code:

Structural Welding Code D1.1.

E. Manufacturers' Standardization Society (MSS):

1. MSS SP-58: Pipe Hangers and Supports - Materials and Design.
2. MSS SP-69: Pipe Hangers and Supports - Selection and Application.
3. MSS SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.
4. MSS SP-90: Guidelines on Terminology for Pipe Hangers and Supports

F. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

G. OSHA

1.04 SEISMIC DESIGN REQUIREMENTS

A. Conform to the requirements as indicated on the structural drawings and as specified herein.

B. It shall be the responsibility of the Contractor to conform to the seismic design requirements for this project and for the work of this specification section.

C. Provide all pipe supports designed in accordance with the seismic requirements indicated and specified.

D. Additionally, provide with the Certificate of Design, certification signed by a registered structural engineer stating that computations were performed and that all components have been sized for the seismic forces specified and indicated.

1.05 SUBMITTALS

Shop Drawings: Submit the following in accordance with the General Conditions:

1. Pipe support drawings specified in paragraph 1.01 and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.
    a. Detailed drawing of the device with dimensions.
    b. A table of applied forces and moments.
    c. A complete bill of materials.
    d. A unique identification and revision level.
    e. Stamp of a Registered Professional Engineer, registered in the State of Georgia, experienced in pipe support design and pipe stress analysis as specified in paragraph. 1.06 D.
    f. Detailed connections to existing structure.
    g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1-1.7.
2. Welding Procedure: Submit description as required to illustrate each welding procedure to be performed in the specified work.
3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.
4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.
5. Pipe support manufacturers' qualifications as specified in paragraph 1.06 D.
    a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.

b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, whom stamps and seals shop drawings and designs.

6. Coordination drawings for pipe supports shall include as a minimum the following information.
   a. Coordination drawings shall include all pipe supports covered by specifications 15060, 15410 and 15891[Verify in Specification Book]
   b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.
   c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.
   d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4 inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-in. or less in diameter that will be field routed need not be shown on coordination drawings.
   e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections as required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.
   f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.
   g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.
   h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.
7. Written notification of any deviations from the requirements of this specification.
8. Support documentation and justification as specified.
9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.

1.06 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, Cast-in-Place Concrete. Concrete strength: 4,000 PSI unless noted otherwise.

C. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

D. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.
2. Have a minimum of 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.

1.07 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.

1.08 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

2.01 MANUFACTURERS

A. Carpenter & Paterson.

B. Grinnell Corporation.

C. Basic Engineers Inc.

D. Or equal.

2.02 MATERIALS:

A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all stainless steel piping. Copper plated pipe supports are not acceptable.

B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, 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. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal.

2.03 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS

A. Design and provide pipe supports for piping ½ in. and larger to include the following loads:

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 metal stairs.
11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.
12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.
13. All pipe supports located in fluid flow shall be supplied with double nutting.

D. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

E. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

F. Pipe supports connected to structural framing and slabs are subject to the following limitations:

1. Less than 100 lb horizontal load per support.
2. Vertical loads not to exceed an average of 25 P.S.F. for slabs, with a maximum vertical load per hanger of 1000 lbs.
3. For a maximum of one pipe support per foot of slab width perpendicular to the span.
4. Vertical loads not to exceed 3,000 lbs. per column or 3,000 lbs. per support at walls.
5. Piping not supported from floors by metal framing must meet the limitations as specified above.

G. All outside above ground supports shall be Type 316L stainless steel as specified in paragraph 2.02(C).

H. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

I. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.04 FABRICATION

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.05 SHOP PAINTING

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces. Refer to Section 09900, Painting 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

3.01 GENERAL

A. Install items in accordance with manufacturers' printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:

1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and

insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.
3. Magnetic Particle Inspection: Perform in accordance with ASTM E 709.
4. Liquid Penetrant Inspection: Perform in accordance with ASTM E 165.
5. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.
6. Test Locations: As selected by the Owner. (Specify minimum of pipes per number of welds and welds linear footage.)
7. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified in Section 03300.

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or as required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 in/ 100 ft, for each 100 deg. F change in temperature exceed ½ in., provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8 in. thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Prevent electrolysis in support of copper tubing by use of pipe supports which are plastic coated. Electrician's tape is not an acceptable isolation method.

K. Apply an anti-seize compound to nuts and bolts on all pipe supports.

L. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:

1. Use existing embedded concrete items whenever possible.
2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES

A. Thrust Anchors:

1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS

A. Where piping of various sizes is to be supported together, space supports for the largest pipe size and install intermediate supports for smaller diameter pipes.

B. Provide minimum of two pipe supports for each pipe piece unless approved by Engineer.

C. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

D. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

E. Unless otherwise indicated or authorized by the Engineer, place piping running parallel to walls approximately 1-1/2 in. out from face of wall and at least 3 in. below ceiling.

F. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

G. Piping supports for vertical piping passing through floor sleeves: use hot dipped galvanized steel riser clamps.

H. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints, and where otherwise indicated. Do not install pipe supports in equipment access areas or bridge crane runs.

I. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

J. Do not support piping from other piping.

K. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

L. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

M. All rigid rod hangers shall provide a means of vertical adjustment after erection.

N. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

O. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

P. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.
2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

Q. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

R. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

S. All threads shall be UNC unless otherwise specified.

T. TFE slide bearing plates with steel backup plates shall be stitch weld attachments to the structure. A 1/8 in. fillet weld, ½ in. long every 3 inches 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.

3.05 INSULATED PIPING

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

+ + + END OF SECTION 15056 + + +

SECTION 15060
PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, equipment and materials required to furnish, install and test, complete the plant piping including all fittings, sleeves, unions and accessories, as specified herein and/or shown on the Drawings. The materials to be used for piping systems are listed by service in the Piping Schedule hereinafter.

B. Contract drawings show only functional feature and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 02200, Earthwork.
2. Section 09900, Painting.

1.02 SUBMITTALS

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

1. Manufacturer's certification.
2. Manufacturer's data.
3. Drawings and engineering data on fabricated piping including locations of all piping supports, anchors, expansion joints, mechanical couplings and all other piping appurtenances.

B. Prior to its incorporation into the work, the Contractor shall submit to the Engineer written evidence that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test results from an independent testing laboratory on samples of pipe materials.

1.03 QUALITY ASSURANCE

Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. American National Standards Institute (ANSI).
2. American Society for Testing Materials (ASTM).

1.04 QUALITY STANDARDS

A. All such work shall be done by competent workmen in a thorough 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.

1.05 STORAGE AND PROTECTION

All piping and tubing and accessories shall be stored above ground fully supported so as not to bend or deflect excessively under their own weight. Piping shall be stored with slope so as to be free draining.

1.06 WARRANTY

Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General

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. Mil Type Galvanized Steel Pipe (2-½-inches and smaller)

1. Steel pipe in sizes from 1-½-inches through 2-½-inches shall be seamless black carbon steel pipe conforming to the requirements of ASTM A-53 Grade B. Pipe 1-½-inches and smaller shall be ASTM A106, Grade B.
2. Unless otherwise specified or shown, steel pipe shall be screwed, Schedule 40. Screwed pipe 2-inch and smaller shall be schedule 80.
3. Screwed fittings shall be 150 pound malleable iron conforming to ASTM A 197 and ANSI B16.3. Unions shall be 300 pound malleable iron, ASTM

A197 or ASTM A47 and ANSI B16.3 with brass to iron seats.

4. Branch connections 2-inch and smaller shall be screwed tees as specified under FITTINGS or 3000-pound WOG forged carbon steel, ASTM A105, Grade II commercial welding branch fittings with threaded outlet, as manufactured by Bonney Forge Division, Gulf and Western Industrial Products Company, Allentown, PA; Allied Piping Products Co., Inc., Norristown, PA; or equal.
5. Screwed pipe couplings shall be malleable iron, ASTM A197 or ASTM A47, dimensions conforming to ANSI B16.3.
6. Flanges shall be 150 pound, forged steel conforming to ASTM A 181, Class 60, and ANSI B16.5. Bolts shall be ASTM A 307, Grade B, cadmium plated. Nuts shall be heavy hex nuts conforming to ASTM A 563, Grade B, cadmium plated. Gaskets shall be of red rubber, 1/16-inch thick, conforming to ANSI B16.21.
7. Unless otherwise shown or specified, steel pipe and fittings shall be hot dip galvanized in accordance with the requirements of ASTM A 153. Exposed steel piping shall be field primed and painted in accordance with the requirements of the section entitled "Painting" of these Specifications.

C. Stainless Steel Pipe, Tubing and Fittings

1. Stainless steel pipe, 3 inches and larger, shall be pickled and passivated, and shall conform to the requirements of ASTM A 778, Type 304L and 316L "as welded" grade. The minimum wall thickness shall be Schedule 10S.
2. Unless otherwise specified or shown, stainless steel pipe 2-½-inches and smaller shall be screwed: ASTM A312, Type 304 or 316, Schedule 40S.
3. Fittings 2-½-inch and smaller shall be screwed, stainless steel, 150-pound, rated 1,000 pound CWP, forgings conforming to ASTM A 182, Grade F304 or barstock to ASTM A 276, Type 304, dimensions conforming to ANSI B16.3.
4. Welded fittings 3-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, Type 304L or 316L and ANSI B16.9. All ells shall belong radius type unless otherwise designated. Elbows 3-inches to 16 inches inclusive shall be smooth flow type. Elbows 18 inches and larger may be fabricated in mitered sections.
5. Branch connections 2-½-inch and smaller shall be screwed tees as specified under Paragraph Fittings, or 3,000-pound WOG forged stainless steel, ASTM A 182, Grade 304L or 316L, commercial welding branch fittings with threaded outlet, as manufactured by Bonney Forge Division, Gulf and Western Industrial Division, Allentown, PA; Allied Piping Products Co., Inc., Norristown, PA; or equal
6. Branch connections 2-inch and larger, including tees or reducing tees shall be as specified under Paragraph Fittings or fabricated from pipe.
7. Flanges shall be 150 pound, forged stainless steel conforming to ASTM A 182, Grade 304 or 316 matching the pipe material and ANSI B16.5. Bolts shall be heavy hex conforming to ASTM A 193, Grade B8M, Type 316 stainless steel. Nuts shall be heavy hex conforming to ASTM A 194, Grade

8M, Type 316 stainless steel. When mating flange on valves or equipment is cast iron, use ASTM A 307, Grade B, square head bolts and ASTM A 563, Grade A heavy hex head nuts. Gaskets shall be red rubber 1/16-inch thick, conforming to ANSI B16.21.

8. Stainless steel tubing shall conform to ASTM A269, and shall be Type 316, seamless, and fully annealed. All tubing supplied shall be standard wall thickness for 200 psi maximum working pressure. Compression type stainless steel fittings shall conform to ASTM A182, with Grade F316 forged bodies or ASTM A276, Type 316 barstock bodies. All tubing fittings shall be flareless and Parker-Hannifin Ferulok or Flodar BA series; or equal.

D. Polyvinyl Chloride Pipe and Fittings (PVC pressure piping)

1. Polyvinyl Chloride Pipe shall be of unplasticized compounds suitable for use with chemicals and sewage, as shown on the Drawings and as specified and shall bear the seal of approval to this effect from an accredited testing laboratory. Pipe shall conform to the requirements of ASTM D1784 and D1785, Schedule 80, Type 1, Grade 1, or class 12454-B.
2. Fittings shall conform to the requirements of ASTM Designation D2467, Class 12454-B for socket type and ASTM Designation D2464 for threaded type.
3. Compounds for pipe and fittings shall conform to the requirements of ASTM Designation D1784, Class 12454-B.
4. Joints shall be the solvent-welded socket or flanged type. Flanges, where shown, shall be 150-pound, and shall be of the same material as the pipe.
5. Bolts for use with PVC flanges shall be as follows:

With Flat Ring Gaskets	Carbon steel, ASTM A307, Grade B square head bolts and ASTM A563, Grade A heavy hex head nuts
With Full Face Gaskets or in Corrosive Areas or Buried	Type 316 stainless steel, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts

6. Gaskets shall be EPDM or Viton, full-faced, and _-inch thick, minimum.
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.

E. 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. Ductile iron pipe and fittings furnished for this project shall be cement lined Type II per ANSI Specification A21.4 (AWWA C104), unless otherwise indicated in the Piping Schedule.
4. Exposed joints shall be flanged or restrained mechanical joints unless otherwise shown on the Drawings. Buried joints shall be push-on or mechanical joints and shall conform to the following requirements:

Flanged	ANSI/AWWA C110 & ANSI B16.1, faced and drilled 125-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

Restraining of joints shall be as recommended in the Cast Iron Pipe Research Association (CIPRA) Handbook of Cast Iron Pipe.

5. Mechanical joints with retainer glands are not acceptable.
6. Flanges shall be ductile iron, threaded, rated for 250 psi working pressure, and conform to ANSI A21.15/AWWA C115 and ANSI 125-pound drilling.
7. For Class 125 FF flanges, carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts shall be used. For mechanical joints, the manufacturer's standard shall be used.
8. Gaskets for mechanical or push-on joints shall be rubber, conforming to ANSI A21.11, AWWA C111. Gaskets for flanged joints shall be 1/8-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.

F. Steel Pipe and Fittings

1. Steel pipe supplied shall be schedule 40 carbon steel, black, electric fusion welded or seamless conforming to the requirements of ASTM A 53, Grade B, with beveled ends. Pipe joints shall be butt-welded or flanged, as specified herein. Tees shall be ANSI B16.4 welding tees.
2. Butt-welded flanges shall be carbon steel, to match pipe wall thickness. Fittings shall be seamless conforming to ASTM A234 and ANSI B16.9. Use long radius elbow unless otherwise noted.

3. Flanges shall be 150 lb. forged steel, conforming to ASTM A181 and ANSI B16.5. Carbon steel, ASTM A 307, Grade A hex head bolts ASTM A 563, Grade A hex head nuts shall be used. Gaskets shall be 1/16-inch thick neoprene, full-face type.

G. 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.

H. Cast Iron Soil Pipe and Fittings

1. Above ground.
   a. Pipe and fittings: Coated service weight cast iron no-hub soil pipe, CISPI 301.
   b. Gasket (Sleeve): Neoprene rubber, CISPI 301.
   c. Compression Band: Stainless steel, CISPI 301.
2. Underground.
   a. Pipe and fittings: Coated service weight cast iron hub and spigot soil pipe, ASTM A74, ANSI A112.5.1, Federal Spec. WW-P-401e.
   b. Gasket: Neoprene rubber, CS-188.

I. 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.

J. Couplings

1. Flexible couplings, flanged coupling adapters, or expansion joints shall be provided for piping systems at connections to equipment, and where shown.

The Contractor may install additional flexible couplings to facilitate piping installation, provided that it submits complete details describing location, pipe supports, and hydraulic thrust protection.

2. Acceptable types of couplings for ductile iron pipe are as follows:

   a. Flexible Couplings: Dresser Style 153 or equal, with zinc-plated bolts and nuts. Thrust ties shall be provided to sustain the force developed by 1-½ times the test pressure specified.
   b. Transition Couplings: Transition couplings used to connect pipes with small differences in outside diameter shall be Dresser Style 162, or equal.
   c. Flanged Adapters:

      1) Flanged coupling adapters shall be used for joining plain end cast iron or ductile iron pipe to flanged valves, pumps and fittings. Flanged adapters shall be suitable for working pressures to 150 psig.
      2) Flanged coupling adapters in sizes 12-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 add grease.

3. Acceptable types of couplings for steel pipe are as follows:
   a. Flexible Couplings: Dresser Style 38,or equal. Thrust ties shall be as specified above for ductile iron pipe couplings.
   b. Transition Couplings: Dresser Style 162, or equal.
   c. Flanged Coupling Adapters: Dresser Style 128,or equal. Thrust restraint shall be as specified above for ductile iron flanged coupling adapters.
   d. Flexible Connectors (Bellows Type): Bellows type flexible connectors shall be Style 1025 (double arched) manufactured by General Rubber Corporation, South Hackensack, NJ, or equal. Connectors shall be rated for a working pressure of 50 psi. The maximum operating temperature is 210^0 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.

K. PIPING INSULATION

1. Indoor Piping Systems:
   a. Insulate indoor piping, shown in Pipe Insulation Schedule, and as 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 all outdoor exposed piping and fittings except A and AA. 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 40^0 F at an ambient temperature of 0^0 F. Heat tape shall be powered by 120V ac single-phase circuits. Heat tape shall be Rapid Trace as manufactured by Chromalox, or equal
   b. Insulate all 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	2" and smaller	2-½" and larger	2" and smaller	2-½" and larger
Potable Water (WP)	1	1	1	1

L. Insulated Underground Piping:

1. Insulation shall be of the factory applied urethane foam type with a polyvinyl chloride (PVC) jacket.
2. Insulated piping shall be suitable for direct burial or installation in pipe trenches. Fluid temperature shall be 35^0 F to 210^0 F. Ground temperatures will range from 35^0 F to 70^0 F, and the piping may be installed below the water table. Provide magnetic tracer tape for insulated underground piping.
3. Preinsulated piping systems shall be Ric-Wil, Thermal Pipe Systems Weldtite, or equal, modified as necessary to provide the specified performance and features.
4. Unless otherwise specified, carrier pipe materials shall be as specified in piping schedule.
5. The urethane foam insulation shall conform to ASTM C591, Type II.
6. All PVC insulation jackets shall conform to ASTM D1784, Class 12454-B. The minimum jacket thickness shall be 60 mils and shall be suitable for H-20 highway loading with 2 feet of cover.
7. Shrinkable sleeves for field joints shall be compatible with the PVC jacket. Shrinkable sleeves shall be fabricated from radiation cross-linked semirigid polyethylene, coated on all inside surfaces with thixotropic adhesive designed to flow and provide a complete seal when heated.
8. Pipe sections shall be prefabricated in such a way that the urethane completely fills the annular space between the carrier pipe and the PVC jacket. The exposed insulation at the end of each sect-ion shall be sealed with a factory-applied, high temperature, watertight sealant, The carrier pipe shall extend a minimum of 6 inches beyond the insulation for field welding.
9. Anchor plates shall be factory fabricated and welded to the carrier pipe. The PVC jacket shall extend up to the anchor plate and be factory sealed to the anchor plate.
10. Fittings shall be factory fabricated and pre-insulated with urethane foam insulation, The insulation shall be protected with a PVC plastic jacket of the same thickness and quality as that of the straight pipe. All miters on the PVC jacket at fittings shall be welded by a thermal set welding process to provide a continuous jacket integrity.
11. Prefabricated elbows, expansion loops, and tees shall be provided, where specified. All pre-insulated fittings that must provide compensation for a pipe expansion and/or contraction installed in a suitably sized jacket and insulated with flexible polyurethane foam insulation. The straight units adjoining expansion fittings shall also be insulated with flexible polyurethane foam

insulation to compensate for lateral pipe movement.

12. End seals shall be provided on ends of each section of preinsulated pipe. The end seals shall be watertight to protect the exposed insulation.

13. Pipe Insulation Schedule

	Insulation Thickness (inches)	
Service	3" and smaller	4" thru 12"
Potable Water (PW)	1	1-½

M. Pipe Hangers and Supports.

1. General
   a. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed. Special support and hanger details are shown to cover typical locations where standard catalog supports are inapplicable.
   b. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing supports for the piping shown on the Drawings at the spacing specified below.
   c. All submerged piping supports, guides, and fasteners shall be Type 316 stainless steel unless otherwise shown. Concrete anchors and anchor bolts shall also be Type 316 stainless steel.
   d. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
   e. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.
2. Building Piping:
   a. Horizontal piping shall be supported with adjustable swivel-ring, split-ring, or Clevis type hangers as shown. Furnish galvanized protection shield and oversized hangers under all insulated piping. Pipe hangers for plastic piping shall be coated with a plastic or neoprene protective cover. No metal portion of a support or hanger shall contact pipe directly.
   b. Stacked vertical and/or horizontal runs of piping along walls shall be supported by a fiberglass framing system attached with Type 316 stainless steel anchors or concrete inserts as applicable, Unistrut, Kin-Line, or equal. No pipe shall be supported from the pipe above or below it.
   c. Pedestal pipe supports shall be adjustable, with stanchion, saddle, and

anchoring flange as shown. Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation. Pads shall be Mason Industries, Inc., Korfund Korpad, or equal.

d. Horizontal piping hanger support rods shall attach to steel beams with C-clamps or beam clamps; to concrete with inserts, brackets or flanges fastened with flush shells; to wood not less than 2-½ inches thick with lag screws and angle clips.

e. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps, Grinnell Figure 261; or equal.

f. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories shall be hot dip galvanized.

g. Horizontal pipe support or hanger spacing and hanger rod sizing shall be as shown on the Drawings.

h. The load rating for universal concrete inserts shall not be less than that of the hanger rods they support.

i. When supporting ductile iron pipe, locate hanger rods at all nonrigid joints and at each change of direction.

j. Vertical sway bracing shall be provided where shown, or on 10-foot maximum centers.

k. All piping shall be supported in a manner which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown.

N. Slab, Floor, Wall, and Roof Penetrations and Closures

1. All piping penetrations of slabs, floors, walls, and roofs shall be ductile iron wall pipes with integrally cast seep rings, unless otherwise noted on the Drawings. It shall be the Contractor's responsibility to verify the size and location of all building and structure penetrations prior to pouring concrete.

a. Ductile Iron Wall Pipes:

1) Provide ductile iron wall pipes where ductile iron piping passes through concrete walls, floors, slabs and roofs which are to be watertight and where shown on the Drawings. Wall pipe end connections shall be as shown on the Drawings and as specified herein. Wall pipes shall be of a thickness equal to or greater than the remainder of the piping in the line and shall comply with the requirements for fittings in the applicable Specifications. All wall pipes shall be provided with seep rings. Seep rings shall be of ductile iron and cast integral with the wall pipe where offered or catalogued by the manufacturer. All wall pipes that cannot be cast with integral seep rings shall be fabricated by welded attachment of the seep ring to the pipe. All welds shall be done in the manufacturer's shop by qualified welders and shall be electric arc welds of ductile iron to ductile iron with NI-55 or FC-55, nickel-iron-carbon weld rod. The seep ring shall be ductile iron, welded continuously

around the pipe on both sides; alternatively, the seep ring shall be steel, as shown in the Standard Details.

2) Flanges set flush with the face of concrete shall be tapped for stud bolts.

3) Coat outside wall of pipes as specified in Section 09900, Painting. Support wall pipes by formwork to prevent contact with reinforcing steel.

b. Pipe Sleeves

1) Piping passing through concrete or masonry shall be installed through galvanized steel pipe sleeves where shown on the Drawings. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls.

2) All sleeves in exterior or water-bearing walls shall have a center flange for water stoppage. The annular space between pipes and sleeves in exterior walls shall be watertight. The joint shall be caulked with rubber sealant, or sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. The interconnected rubber links shall be assembled with zinc phosphate-plated steel bolts and nuts and steel pressure plates under each bolt head and nut to prevent the nut from turning when the bolt is tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings.

3) Wall sleeves shall be coated with the appropriate system for the intended location as specified in Section 09900, Painting. When placing non-insulating type wall sleeves in concrete forms, support them by formwork to prevent contact with the reinforcing steel.

O. Polyvinyl Chloride Pipe and Fittings (PVC Gravity Pipe):

Polyvinyl chloride pipe shall be of unplasticized compounds suitable for use with wastewater

P. Flexibility:

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.

Q. Expansion Joints:

1. Expansion joints shall be designed in accordance with Expansion Joint Manufacturer's Association (EJMA) standards for pressure, temperature and service as specified.
2. Expansion joints shall be multi-ply bellows type designed for temperatures up to 300^0 F and pressures up to 25 psig. Bellows shall be constructed of 300 series stainless steel. Unless otherwise specified, end connections shall be flanged. Flanges shall be of stainless steel construction.
3. The type of expansion joints and schedule is specified on the Drawings.
4. Expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA, Inc., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All exposed piping shall be firmly anchored and supported by pipe supports or anchors as shown or required. Pipe supports shall be furnished as shown on the Drawings or in accordance with the requirements of Paragraph 2.01 M of this section. All 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. Installed piping shall not interfere with the operation of or accessibility to doors and/or windows, shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment.

9. The interior of all piping shall be free from obstructions and protrusions. All burrs shall be removed from the inside and outside edges of all cut pipe by reaming. Cutting shall be done in such a manner so as to leave a smooth end at right angles to pipe threads. Tool marks and unnecessary pipe threads shall be avoided. Cuttings and other foreign material shall be removed from the inside of the pipe prior to installation.
10. After installation, the interior of all piping shall be cleaned as necessary to remove flux, slag, scale, rust, dirt, oil, and other foreign material. As piping is installed, open ends shall be covered or plugged as necessary to prevent the entrance of foreign matter and to maintain the required cleanliness.
11. Changes in pipe size shall be made using reducing fittings, not bushings. If centerline elevation is not specified, use eccentric reducers in horizontal piping. On liquid lines, eccentricity shall be down with top of pipe level. On vapor and gas lines, eccentricity shall be up with bottom level.
12. Indicated locations and sizes of equipment connections are approximate; exact locations and sizes of piping, valves, etc., shall conform to approved shop drawings. Connection sizes shall not be smaller than scheduled size or equipment outlet size, whichever is larger.
13. One inch vent and drain valves shall be inserted in all high and low points of all pipes.
14. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.
15. Minimum pipe cover shall be 3 feet, as measured from the pipe barrel, unless otherwise indicated on the Drawings.

B. Installation of Steel Piping

1. Pipe threads shall be concentric with the outside of the pipe and shall conform to ANSI B2.1. When threading stainless steel pipe, dies shall have 20 to 30 degree hook. Finished joints shall have no more than three threads exposed. Before assembly, pipe ends and threads shall be inspected and any defective pieces replaced. All joints shall be properly aligned before connection to prevent thread damage. Pipe dope shall be used on the male threads of all threaded connections. Teflon thread tape shall be applied two threads back from the end of the pipe of fitting to prevent shredding. Excess pipe dope shall be trimmed or cleaned off to provide adherence for paints or coatings. After joining, exposed threads in underground piping shall be given a heavy coat of bituminous paint or other suitable protective compound prior to backfilling.
2. All flanges shall be faced and drilled and shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe. Where slip-on flanges are used, the distance from the end of the pipe to the gasket face of the flange shall not exceed "t" plus 1/4-inch, where "t" is the pipe wall thickness. Unless otherwise required, bolt holes shall straddle the vertical and horizontal axes of the

pipe. Connections to equipment shall be made in such a way that no strain is placed on the equipment flanges.

3. Flexible bellows-type connectors shall be installed in their undeformed configuration, in accordance with the joint manufacturer's instructions. Control rods shall be installed to permit fully rated expansion joint compression, and to limit expansion joint extension to 1/16-inch.
4. For flanged connections between steel piping and cast or ductile iron piping or valves, steel flanges shall be flat faced and furnished with full-face gaskets, insulating bushings, and, when buried, stainless steel bolts.
5. Where steel pipe is connected to copper tubing, insulating bushings or couplings shall be used to prevent galvanic corrosion.

C. Installation of Stainless Steel Pipe, tubing and fittings:

1. Welding electrodes for shielded metal arc process on Type 304L and 316L stainless steel pipe shall be AWS 5.4, E 308L; Gas Tungsten Arc or Gas Metal Arc process shall be AWS 5.9, ER 308L. The direct current, reverse polarity, shielded metal arc or gas metal arc processes or direct current, straight polarity, gas tungsten-arc process shall be used for all field welding.
2. All welding shall be conducted in accordance with latest editions of Section IX, ASME Boiler and Pressure Vessel Code and the American National standard Code for Pressure Piping, ANSI B31.2 and B31.3, as applicable.

    a. All welders and welding operators shall be qualified at the Contractor's sole expense by an 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 304, 304L, 316 and 316L stainless steel pipe in position 6G for each welding process to be used.
    b. Pipe edges shall be prepared preferably by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting are acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ANSI B16.25. Surfaces to be welded shall be clean and free of paint, oil rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool.
    c. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 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.

D. Installation of PVC Pipe and Fittings:

1. All PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturers recommendations. Plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and final use.
2. Use Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting. All PVC to metal or PVC to FRP pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings, nor shall PVC piping be threaded into metal valves, fittings, or couplings.
3. Only strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to overtighten these fittings. Pipe shall not be laid when the temperature is below 40 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.

E. Installation of Ductile Iron Pipe:

1. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
2. Ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections which may damage the rubber gasket. Dress cut ends of pipe for flexible couplings and flanged coupling adapters, as recommended by the coupling or adapter manufacturer. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
3. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.
4. Mechanical joint push-on, and restrained joint pipe shall be joined in accordance with the manufacturer's recommendations. Provide all special tools and devices such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.

F. Installation of Sanitary and Waste Drain and Vent Piping.

1. Set sanitary and waste drain and vent piping installed above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Make roof penetrations watertight.
4. Extend vents at least 1 foot above roof.
5. Properly slope sanitary and waste drainage piping encased in concrete.
6. Coordinate routing of drains through steel reinforcement with affected trades.
7. Make changes of direction in waste piping with combination Y and _ bend fittings.
8. Cleanout Fittings and Plugs:
    a. Install where shown and where required by plumbing code.
    b. T or Y branches or trap hubs shall be of the same material as the pipe in which they are installed.

G. Installation of Roof Drainage Piping.

1. Make changes of direction in horizontal roof drainage piping with 45-degree fittings.
2. Make changes of direction in underground lines with combination Y and _ bend fittings.
3. Cleanout Fittings and Plugs:
    a. Install where shown and where required by plumbing code.
    b. Same material and size as pipe in which they are installed.

H. Buried Piping System Thrust Restraint

1. General: Thrust restraint for all buried ductile iron pressure piping systems shall be accomplished by the use of restrained joints as specified hereinbefore.
2. Buried Pressure Pipelines:
    a. Thrust restraint shall be capable of restraining the buried pressure pipelines for pressures up to 1-½ times the corresponding hydrostatic test pressures listed in the Piping Schedule.
    b. Restrained joint type fittings for ductile iron pipe shall be as specified hereinbefore.

I. Pipe Dope:

1. All threaded connections shall be made up using Teflon pipe dope applied to the male threads only.
2. Virgin Teflon thread tape shall be Hercules Packing Company "Herculon", 3-M Company "Scotch No.48", Crane Packing Company "Teflon Thread tape", or equal.
3. Teflon thread paste may be used in place of tape on very large or very small joints.

J. Wall Pipes and Pipe Sleeves

1. The Contractor shall provide restrained joints for all buried piping, except RCP, with test pressure higher than 20 psig.
2. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300, CONCRETE and as shown. Support all pipes embedded ill concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

K. Flexible Couplings, Flanged Coupling Adapters, and Service Saddles

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 in accordance with manufacturer's instructions including types of insulating cements, lagging adhesives, and weatherproof mastics if different from those specified.
2. All insulation shall be applied over clean, dry surfaces with all joints butted firmly together, but not until piping system has been pressure tested and any leaks corrected. Insulation shall not extend beyond flanges nor cover nameplates or code inspection stamps. Insulation shall run continuous through wall openings, ceiling openings, and pipe sleeves, unless otherwise noted.
3. Where connection is shown to existing piping, the existing insulation shall be cut back to remove the portion damaged by the piping revisions, and new insulation installed. The joint between the old and new insulation shall be finished as hereinbefore specified.
4. The Contractor shall furnish precut, sized sections of closed cell rigid insulation with vapor barrier to be inserted under piping and centered at each hanger location. Provide continuous vapor barrier at all joints between rigid insulation and pipe insulation.

5. Insulate all valve bodies, flanges, and pipe couplings. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc. Do not insulate flexible pipe couplings.
6. Finished appearance of all insulation shall be smooth and continuous. Provide coating of insulating cement where needed to obtain this result. Joints shall be lapped and the integrity of vapor seals maintained in strict accordance with manufacturer's instructions. Staples and screws shall not be used to secure components of systems that are vapor sealed.
7. Care shall be taken to apply the insulation and vapor barrier coating on exterior piping so that it will not be damaged when the prefabricated aluminum fitting covers are applied. The prefabricated aluminum covers shall serve as weatherproof enclosures over fittings. No screws or rivets shall be used in fastening the fitting covers, as they may puncture the vapor seal.
8. Exterior flanges and unions shall have removable prefabricated aluminum covers.
9. Heat Tracing: Install heat tracing tape in strict accordance with the manufacturers's recommendations and make electrical connections.

3.02 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.

3.03 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.

3.04 PIPING IDENTIFICATION

A. Piping Systems. Identification of piping systems shall conform to ANSI A13.1, Scheme for the Identification of Piping Systems, unless otherwise specified herein.

B. Process Piping Code. All exposed pipe shall be identified by color and labeling to show its function. Stencil-painted labels and arrows showing the direction of flow shall be installed every 20 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.

3.06 TESTING

A. General: Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests. Test pressures shall be as specified in the Piping Schedule.

B. Testing New Pipe Which Connects to Existing Pipe: New pipelines which are to be connected to existing pipelines shall be tested by isolating the new Pipe.

C. Preparation and Execution:

1. Buried Pressure Piping:
   a. Conduct final acceptance tests on buried pressure piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed.
   b. Buried pressure piping that is to be pneumatically tested or subjected only to an initial service leak test shall have all joints exposed for the acceptance test.
2. Exposed Pressure Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors, but prior to insulation.
3. Hydrostatic Leak Tests:
   a. Equipment: Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

   b. Procedure: Water shall be used as the hydrostatic test fluid unless

otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The hydrostatic test pressure shall be continuously maintained for time duration specified in pipe schedule and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

C. Buried Water and Wastewater Pressure Lines:

1. Some leakage is permissible from buried water and wastewater pressure lines. Consequently, the hydrostatic testing of these pipelines must be conducted in a different manner, as follows:
2. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 5 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 2 days. When testing cement-mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.
3. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

In the above formula:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

The Contractor shall correct any leakage greater than the allowance determined under this formula at the Contractor's sole expense.

4. Pneumatic Leak Tests:

a. Equipment: Furnish the following equipment for the pneumatic tests:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure
1	Calibrated test gauge

b. Procedure:

1) Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Tests shall be performed only on exposed piping, but only after the piping has been completely installed, including all supports, hangers and anchors, and inspected for proper installation. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The Contractor shall recognize the hazards associated with air testing and shall take all necessary precautions to protect test personnel and City's operating personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenant instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to applying the test. Prior to starting the test, the Contractor shall notify the Engineer.

2) A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than ½ of the test pressure, after which the pressure shall be increased in steps of approximately 1/10 of the test pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage. Any visible leakage shall be corrected at the Contractor's sole expense.

3) Following pneumatic testing, lines which are to carry flammable

gases shall be thoroughly purged with nitrogen to assure that no explosive mixtures will be present in the system during the filling process.

5. Initial Service Leak Tests:
   a. Equipment: Equipment used for initial service leak testing may be the same as that specified under Paragraphs Hydrostatic Leak Tests and Pneumatic Leak Tests hereinbefore.
   b. Procedure: The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.
6. 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
8. Remarks, to include such items as:
   a. Leaks (type, location)
   b. Repairs made on leaks

3.06 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.

3.07 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 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.

3.08 Corrosion Protection of Piping Systems

A. All atmospheric exposed piping and piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09900, Painting, as applicable to the base metal material.

B. Pipe support systems shall be painted No. 70, light gray, as specified in ANSI Z55.1; Tnemec Co., Inc. No. 2050; or equal.

C. Corrosion protection for buried piping systems, other than copper piping, is not required.

3.09 Corrosion Protection for Copper Piping

A. For Atmospheric Exposed Copper Pipe: Copper piping shall be painted in accordance with Section 09900, Painting, System No. 5.

B. Exterior Coating for Buried Copper Pipe: All buried copper pipe shall be coated by hand taping with pipe tape. The pipe surface shall be solvent cleaned, SSPC-SP 1, and wire brushed, SSPC-SP 3, to remove all dirt and loose rust and mill scale, and immediately primed with the tape manufacturer's recommended primed in accordance with the manufacturer's recommendations. The tape shall be spirally applied to the pipe with a 50 percent overlap minimum after the primer has thoroughly dried. Joints shall be tape wrapped or heat shrink wrapped above grade to permit joint wrapping without contamination. Tape wrapping and heat shrink wrapped are specified under Paragraph MATERIALS.

3.10 DISINFECTION

A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-86, as hereinafter modified or expanded.

B. Flushing: Before disinfecting, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc. as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at the higher velocity.

C. Disinfecting Mixture:

1. Disinfecting mixture shall be a chlorine-water solution having a free chlorine residual of 50 ppm, minimum. The disinfecting mixture shall be prepared by injecting: (1) A liquid chlorine gas-water mixture; (2) dry chlorine gas; or (3) a calcium or sodium hypochlorite and water mixture into the pipeline at a measured

rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.

2. The liquid chlorine gas-water mixture shall be applied by means of a standard commercial solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.
3. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a 1 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.

6. Collect two samples or sets of samples from each pipe or facility at least 24 hours apart. Submit samples to a state-approved laboratory for bacteriological (coliform and non-coliform) analysis. Continue disinfecting and testing until bacteriological clearance is achieved.

+++ END OF SECTION 15060 +++

PIPING SCHEDULE
(Modify as required)

SERVICE	FLOW STREAM ID	SIZE (IN)	MATERIAL		Specification No.	PRESSURE (PSIG) (2)		
			Exposed	Buried		Type*	Pressure psig	Test duration, hours
Aeration air	A	2-½ or smaller	SS 304	SS 304	15060-2.01C	P	25	2
		3 thru 42	SS 304 L	SS 304 L	15060-2.01C	P	25	2
Agitation air	AA	2-½ or smaller	SS 304	SS 304	15060-2.01C	P	25	2
		3 thru 42	SS 304 L	SS 304 L	15060-2.01C	P	25	2
Acetic acid	ACA	All	PVC	PVC	150602.01D	H	150	2
Backwash air	BA	2-½ or smaller	SS 304	SS 304	15060-2.01C	P	25	2
		3 thru 42	SS 304 L	SS 304 L	150602.01C	P	25	2
Backwash water	BW	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	150	2
Chilled water return	CHWR	2 and under	Copper type L	Preinsulated piping system, type L copper	15060-2.01G&L	H	75	2
		2-½ or larger	Black steel	Preinsulated piping system, black steel pipe	15060-2.01F&L	H	75	2
Chilled water supply	CHWS	2 and under	Copper type L	Preinsulated piping system, type L copper	15060-2.01G&L	H	75	2
		2-½ or larger	Black steel	Preinsulated piping system, black steel pipe	15060-2.01F&L	H	75	2
Chemical drain	CMD	12 and smaller	PVC	PVC	15060-2.01D	H	20	2
Chemical overflow	COF	12 and smaller	PVC	PVC	15060-2.01D	H	20	2
Cold water	CW	3 and under	Copper type L	Copper type K	15060-2.01G	H	150	1
		4 and larger	Ductile iron (cement lined)	Ductile iron (cement lined)	15060-2.01E	H	150	1
Drain	D	3 and smaller	Galvanized steel	CISP under 5 ft. PVC beyond 5 ft. outside bldg.	15060-2.01B&H 15060-2.01P	H H	20 20	2 2

		4 thru 12	CISP	CISP under 5 ft. PVC beyond 5 ft. outside bldg.	15060-2.01H 15060-2.01P	H H	20 20	2 2
Drain (Cont.)	D	14 and larger	Ductile iron	Ductile iron under 5 ft. PVC beyond 5 ft. outside bldg.	15060-2.01E 15060-2.01E 02433	H H	20 20	2 2
Dewatering centrate	DC	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Ferric chloride	FC	All	PVC	PVC	15060-2.01D	H	150	2
Final effluent	FEFF	60 and larger	-	RCP	02433	H	50	2
Filtered water	FW	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
HCL gas	HCL	1 and under	Monel	Monel	11374-2.04D	P	50	2
High pressure sludge gas	HSG	2-½ and smaller	SS 316	SS 316	15060-2.01C	H	150	2
		3 thru 6	SS 316 L	SS 316 L	15060-2.01C	H	150	2
Hot water	HW	3 and under	Copper type L	Copper type K	15060-2.01G	H	150	1
		4 and larger	Ductile iron (cement lined)	Ductile iron (cement lined)	15060-2.01E	H	150	1
Hot water return	HWR	2 and under	Copper type L	Preinsulated piping system, type L copper	15060-2.01G&L	H	75	2
		2-½ and lager	Black steel	Preinsulated piping system, black steel pipe	15060-2.01F&L	H	75	2
Hot water supply	HWS	2 and under	Copper type L	Preinsulated piping system, type L copper	15060-2.01G&L	H	75	2
		2-½ and lager	Black steel	Preinsulated piping system, black steel pipe	15060-2.01F&L	H	75	2
Lube oil return	LOR	12 and smaller	Black steel	-	15060-2.01F	H	150	1
Lube oil supply	LOS	12 and smaller	Black steel	-	15060-2.01F	H	150	1
Mixed liquor	ML	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
		60 and larger	-	RCP	02433	H	50	2
Sodium hypochlorite	NaOCL	All	PVC	PVC	15060-2.01D	H	150	2
Overflow	OF	3 and smaller	Galvanized steel	PVC	15060-2.01B&D	H	20	2

		4 thru 12	Cast iron soli pipe	PVC	15060-2.01D&H	H	20	2
		14 and larger	Ductile iron	RCP	02433 15060-2.01E	H	20	2
Pumped drainage	PD	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Primary effluent	PE	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Polyelectrolyte	POL	All	PVC	PVC	15060-2.01D	H	150	2
Rain leader	RL	4 and larger	Cast iron soil pipe (CISP)	Cast iron soil pipe (CISP)	15060-2.01H	H	20	2
Return activated sludge	RAS	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
		60 and larger	-	RCP	02433	H	50	2
Service air	SA	3 and under	Copper type L	Copper type K	15060-2.01G	H	200	2
Sanitary drain	SAN	1-½ and smaller	Copper type L	Copper type K	15060-2.01G	H	50	2
		2 and larger	CISP	CISP PVC beyond 5 ft.outside bldg.	15060-2.01D&H	H H	20 20	2
Secondary effluent	SE	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
		60 and larger	-	RCP	02433	H	50	2
Storm drain	STD	3 and smaller	Galvanized steel	CISP under 5 ft. PVC beyond 5 ft. outside bldg.	15060-2.01B&H 15060-2.01P	H H	20 20	2 2
		4 thru 12	CISP	CISP under 5 ft. PVC beyond 5 ft. outside bldg.	15060-2.01H 15060-2.01P	H H	20 20	2 2
		14 and larger	Ductile iron	Ductile iron under 5 ft. RCP beyond 5 ft. outside bldg.	15060-2.01E 15060-2.01E 02433	H H	20 20	2 2
Thickening centrate	TC	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Tank drainage	4 thru 54	Ductile iron	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Thickened waste activated sludge	TWAS	3 and smaller	Galvanized steel	-	15060-2.01B	H	125	2
		4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
UV system air	UVA	2 and smaller	SS 316	SS 316	15060-2.01C	P	20	2

UV system chemical recirculation	UVC	4 and smaller	PVC	PVC	15060-2.01D	H	150	2
UV system water	UVW	2 and smaller	SS 316	SS 316	15060-2.01C	H	150	2
Vent	V	1-½ and larger	CISP	CISP	15060-2.01H	H	20	2
Vacuum	VAC	2-½ and smaller	Copper type L	Copper type K	15060-2.01G	H	50	2
		3 and larger	Ductile iron	Ductile iron	15060-2.01E	H	50	2
Chemical vent	VC	12 and smaller	PVC	PVC	15060-2.01D	H	20	2
Waste backwash water	WBW	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	150	2
Waste activated sludge	WAS	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Potable water	WD	3 and under	Copper type L	Copper type K	15060-2.01G	H	150	1
		4 and larger	Ductile iron (cement lined)	Ductile iron (cement lined)	15060-2.01E	H	150	1
Waste foam	WF	4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	125	2
Reuse water	WR	2-½ and under	Galvanized steel	PVC	15060-2.01B&D	H	225	2
		4 thru 54	Ductile iron	Ductile iron	15060-2.01E	H	225	2
Service water	WS	3 and under	Copper type L	Copper type K	15060-2.01G	H	150	1
		4 and larger	Ductile iron	PVC	15060-2.01D&E	H	150	1
Landscape irrigation water	WSL	3 and under	Copper type L	Copper type K	15060-2.01G	H	150	1
			Ductile iron	PVC	15060-2.01D&E	H	150	1

NOTES:
* = P - Pneumatic
H - Hydrostatic

SECTION 15100
VALVES

PART 1 - GENERAL

1.01 SCOPE

A. Work Included in This Section. The work of this Section shall include the furnishing, installation and testing of all valves and required appurtenances as specified herein, shown on the Drawings and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other Sections of these specifications. Items to be provided include but shall not be limited to the following:

1. Valves.
2. Check Valves.
3. Manual Operators, floor stands, and valve boxes.

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 15060 - Piping and Appurtenances.
2. Section 09900 - Painting.
3. Division 13 - Instrumentation and Control.

1.02 SUBMITTALS

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

B. 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.

C. For each motor driven actuator, provide, motor currents at the specified voltage for each actuator, corresponding to locked rotor, maximum seating torque, average running load and speed. Supplier shall give full information concerning actuator dimensions and weights.

D. 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.

1.03 VALVE SCHEDULE

Valves shall be of the type shown on the Drawings or of the rating and construction as specified in Tables I and II comprising Valve Schedule. All motorized valves of the same type shall be of the same make unless otherwise approved and shall be in accordance with Table II or as specified herein.

PART 2 - PRODUCTS

2.01 OPERATORS

A. General. 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.

1. Gate and Globe Valves. All gate, globe and angle valves shall be fitted with handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.
2. Butterfly Valves. Unless the Drawings indicate otherwise or the valves are six feet or more above the operating floor level, all butterfly valves shall be lever operated. The operators shall be furnished by the manufacturer of the valve, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operators shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be for the service and all exposed nuts, bolts, springs, washers shall be stainless steel.
3. Chainwheel Operator. All valves six feet or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel operator and shall be the valve manufacturer's standard, with galvanized chain to be furnished in the length required for operation.
4. 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.
    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 10 psi.
    c. Valves shall be installed with extension stems, as required, and valve boxes.

B. On quarter-turn valves, 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. 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. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.

2.02 SOLENOID VALVES

Two-way solenoid valves shall be forged brass bodies, Buna "N" or Teflon seals and disks, with, 120 VAC, 60 Hz operated solenoid coils. All coils shall be housed in NEMA 4 cases with provision for ½-inch electrical conduit. Acceptable manufacturers are ASCO, Skinner, Magnetrol or equal. Specific solenoid valves to be provided are listed in the Valve Schedule, Table I.

2.03 PRESSURE CONTROL VALVES (SELF CONTAINED)

Pressure control valves of the spring loaded self contained type shall be provided as shown on the Drawings and specified herein. The valves shall be for regulating back pressure or discharge pressure and shall be direct diaphragm operated, spring controlled, bronze body designed for domestic and industrial water service. The valves shall be sized in accordance with the required flow rate, pressure differential, inlet or outlet pressure range as shown in Table I of the Valve Schedule. The pressure control valves shall be as manufactured by Fischer Controls, GA Industries, Claval or equal.

2.04 MANUALLY OPERATED VALVES

A. Gate Valves:

1. V102: Gate valves 2 inches and smaller shall be all-bronze with screwed bonnet and ends, single solid wedge gate, and rising stem. Valves shall be rated 125-pound SWP, 200-pound WOG, and shall be Stockham B107, Crane Co. Cat. No. 428, or equal.
2. V110: Gate valves 2-1/2 inches and larger shall be iron body, bronze-mounted valves with flanged ends, solid wedge gate, and outside screw and yoke. Valves shall be rated 125-pound SWP, 200-pound WOG, and shall be Crane Figure No. 465-1/2, or equal.
3. V122: Gate valves 2-½ inches and larger for buried water service shall be iron body, bronze-mounted valves with push-on or mechanical joint ends, double-disc gate, nonrising bronze stem, O-ring sealed stuffing box, and 2-inch square wrench nut conforming to AWWA C500. Valves shall be rated 150-pound WOG minimum, and shall be American-Darling No. 55, or equal.
4. V144: Indicator post valves shall be UL listed, iron body, bronze-mounted, nonrising stem gate valves rated 175-pound WOG, with ANSI A21.11, 125-pound mechanical joint ends. The gate shall be a double-disc type with bronze wedge pins and parallel seats. The gate stem shall be sealed with a double O-ring pressure and dirt seal. The valve bonnet shall include a bolted flange for mounting the indicator post. The indicator post shall be a locking type with an adjustable barrel and weather-sealed indicator window to display OPEN and SHUT positions. The indicator post valves shall be Kennedy Figure 71X, American-Darling 55U, or equal. The indicator posts shall be Kennedy Figure 541, American-Darling IP71, or equal.

B. Globe Valves:

1. V200: Globe valves 3 inches and smaller shall be all bronze with ends to match adjoining piping, union bonnet, inside screw, rising stem, and TFE disk. Valves shall be rated 150-pound

SWP, 300-pound WOG, and shall be Stockham Figure B-22, Crane Co. Cat. No. 7TF, or equal.

2. V235: Angle type hose valves 3/4 inch and smaller shall have brass or bronze body, with rising stem and composition disc, rated 250-pound WOG minimum. Valves shall have American standard hose thread outlet. Valves shall be Fairbanks Figure 74, DeSanno No. 111 or 11, or equal.
3. V236: Globe style hose valves 1-inch through 3-inch shall be all-bronze, with screwed ends, inside screw, rising stem, and TFE disc. Outlet shall have a cast brass NHT by NPT, male by male, nipple adapter with hexagonal wrench feature. Valve shall be rated 300 WOG and shall be Crane Co. Cat. No. 7TF, Stockham Figure B-22, or equal globe valve.

C. Ball Valves:

1. V300: Ball valves 2 inches and smaller, for general water and air service, shall be all bronze, end entry type, with screwed ends, full bore ports, Teflon seats and packing, and hand lever operators, rated 400 psi at 200 degrees F. Install union adjacent to valves to provide access to seats. Valve shall be Jenkins Figure No. 900-T, Lunkenheimer Figure No. 708HST, or equal.
2. V301: Ball valves 2-½-inches and larger, for general water and air service, shall be all cast iron, top entry type, with Class 125 flanged ends, PTFE seats and hand lever operators. Valves shall be Watts B-4000, Crane No. 941-TRE, or equal.
3. V307: Ball valves shall have Type 316 stainless steel bodies with Type 316 stainless steel balls. Valves shall be of the top entry type with screwed ends, rated 300-pound WOG. Seat, body seal, and stem packing shall be reinforced TFE. Valves shall have lever operators. Valves shall be Hills-McCanna Figure S302-S6-R, Contromatics Figure C-161 l-CC, or equal.
4. V301: PVC valves 3 inches and larger shall be rated 150 psi at 105 degrees F with ASTM D1784, Type 1 polyvinyl chloride full port bodies. Valves shall have Teflon seats and Viton O-ring stem, face and carrier seals. Valves shall be end entry design with dual union, solvent weld socket ends, or single union ball valves with flanged ends drilled to 150-pound ANSI Standard. Valves shall be Nibco; McCannaplast Series 150 as manufactured by Hills McCanna Company, Carpentersville, IL; GSR valves as manufactured by R&G Sloane Manufacturing Company, Inc., a subsidiary of the Susquehanna Corp., Woodland Hills, CA; or equal.

D. Plug Valves:

V405: Eccentric plug valves 4 inches through 24 inches shall be suitable for buried, submerged and exposed service with ends matching those shown on the Drawings. Valves in buried or submerged service shall have extension stems and shall be suitable for installation in a valve box, with tee-handle wrench operation. Buried or submerged valves shall be of the nonlubricated type with manual nut operators for valves 6 inches and smaller, and totally enclosed, geared, manual operators for valves 8 inches and larger. Exposed valves shall be the nonlubricated type with wrench lever manual operators for valves 6 inches and smaller and totally enclosed, manual handwheel operators for valves 8 inches and larger. Valves shall be rated 150-pound WOG minimum, and shall have a cast iron body with joint ends to match adjoining piping, balanced plug coated with Hycar or EPT elastomer, Buna-Vee packing or O-ring seals, stainless steel bearings, and nickel or epoxy-coated seats. Ends shall meet 125-pound ANSI Standards. Valves shall be Homestead Figure 1100 and 1500, Keystone Ballcentric, DeZurik Series 100, or equal.

E. Butterfly Valves:

1. General: Butterfly valves specified as AWWA C504 shall be in full compliance with AWWA C504 and the following requirements:
   a. Valves shall be suitable for throttling operations and for very infrequent operation after extended periods of inactivity.
   b. Elastomer seats that are bonded or vulcanized to the body shall have the adhesive integrity of the bond between seat and body assured by sample testing with a minimum 75-pound pull in accordance with ASTM D 429, Method B .
   c. Inside diameter at seat shall not be less than the inside diameter of the connecting pipe by more than 1 inch.
   d. Valves shall be bubble-tight with rated pressure applied from either side of the valve disc.
   e. There shall be no travel stops for the disc on the interior of the body.
   f. Shaft seals shall be self-adjusting split-V type.
   g. Thrust bearing surfaces of metal-to-metal shall not be exposed in the flowstream of the valve.
   h. An affidavit shall be furnished from the manufacturer certifying that the valves are in full compliance with AWWA C504.
2. V500: Standard service butterfly valves 24 inches and smaller shall be wafer, short body type, AWWA 75B, with enclosed worm gear manual hand wheel operators. Valves shall be Class 150B. Valves shall have ASTM A126, Class B, cast iron valve body and disc. Valve shaft shall be Type 304 stainless steel. Valve seat shall be attached to the valve body and shall be of EPDM and be suitable for 240 degrees F. Self-adjusting packing suitable foe 210 degrees F service shall be provided. Valves shall be Henry Pratt, Triton XR-70, American Darling 75B, or equal. Motorized flow control valves shall be Fisher Model 1052-8522 or equal.

F. Check Valves:

1. V608: Swing check valves 2 inches through 36 inches shall be in accordance with AWWA C508 and shall be flanged end, faced and drilled in accordance with ANSI B16.1 Class 125, cast iron body, bronze-mounted valves, with solid bronze hinges and stainless steel hinge shaft. Valves 2 inches through 12 inches shall be rated 175-pound and 14 inches through 36 inches rated 150-pound cold water, nonshock. Valves shall be fitted with adjustable outside lever and heavy-duty spring. Increasing-pattern body valves may be used where the outlet piping size is shown increased on the Drawings. Valves shall be M & H Valve Style 59, 159, or 3259; American Darling No. 50 Line; or equal.
2. V632: Ball check valves 3 inches and larger shall be flanged end iron body valves with cleanout and a sinking type hollow steel ball with vulcanized nitrile rubber exterior. Flanges shall be ANSI B16.1 Class 125. Valve shall be rated 150-pound WOG, suitable for vertical up or horizontal flow. Valve shall be as manufactured by Flygt Corp., Flomatic Corp., or equal.
3. V642: 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 ASSE 1013. Assembly shall be Watts Regulator Co., Inc., Model 909 NRS.

G. Needle Valves: Chemical feed needle valves shall be non-shock, thermoplastic type of Type 1, Grade 1 PVC with O-ring stem seal and teflon stem seat. Valve shall withstand 150-psi pressure and shall incorporate a positive stop for safe operation. All parts shall be corrosion resistant materials, specifically suited for process chemical.

2.05 AUTOMATIC VALVES

Surge Relief Valves

Type II: Surge relief valves shall be self-contained, 150-pound flanged ends, cast iron body, Buna-N sleeve with externally-adjusted relief valve. Valve shall be leak-tight at shutoff. The self-contained system shall include an oil-filled reservoir and an adjustable speed control valve with relief valve. The valve shall minimize surges in the system, shall close in a slow controlled manner, and shall be equipped with a limit switch for signal indication remotely. Limit switch shall be for 120-volt, single-phase, 60-cycle electrical characteristics and shall open when the valve opens. Valve size, pressure and flow shall be as given in Valve Schedule herein. Valve shall be Red Valve Series RSR as manufactured by Red Valve Company, Inc., Carnegie, PA, or equal.

2.06 PRESSURE REDUCING VALVES (PRV) (½-inch to 2-inch size)

A. Provide bronze body, spring controlled, adjustable pressure reducing valve with threaded connections.

B. Provide valves with high temperature diaphragm and renewable nickel alloy seat.

C. Provide with thermal expansion bypass.

D. Provide with separate bronze strainer with 20 mesh stainless steel basket. Attach to valve with bronze nipple.

E. Rated for 150 psig maximum inlet water pressure with adjustable 25-75 psig outlet water pressure.

F. Pressure reducing valves shall be Watts 223SB or approved equal.

2.07 BACKFLOW PREVENTORS

A. Backflow preventors shall be the reduced pressure type, providing protection during the emergency conditions of either back-siphonage or backpressure or a combination of both. Backflow preventors shall be certified by a nationally recognized testing laboratory as conforming to current requirements of ASSE 1013, AWWA C 506, or USC-FCCC. The installation shall meet all applicable state and local codes.

B. Sizes ¾-inch through 2-inches shall have bronze bodies with threaded connections, a bronze union on either side and a stainer installed upstream of the device. Gate valves shall be installed upstream and

downstream of the device.

C. Sizes 2-1/2-inches and larger shall be bronze or iron bodied with corrosion resisting moving parts and trim and flange connections. Gate valves shall be installed upstream and downstream of the device.

D. 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 and shall be supported independently from the device.

E. Backflow preventers shall be manufactured by Watts, Wilkins, Hersey or equal.

2.08 MISCELLANEOUS VALVES

Post Hydrants:

1. V930: Fire hydrants shall conform to AWWA C502 standard for dry-barrel fire hydrants. Fire hydrants shall have a nominal 5-½-inch main valve with 6-inch mechanical joint inlet connections. Outlet nozzles shall be 2-½-inch hose nozzles and one 4-½-inch pumper nozzle with national (American) Fire Hose Coupling Screw Threads. The main valve shall be equipped with O-ring seals and shall open to the left (counterclockwise). Hydrants shall be of the break-flange or safety-top type and shall be painted as directed by the Engineer above the ground line. Fire hydrants shall be as manufactured by Mueller, Kennedy or equal.
2. V935: Post hydrant shall be J. R. Smith Figure 5910 series, or equal, with bronze casing, 1-1/2-inch inlet and outlet size unless shown otherwise on the Drawings, with 3 feet of bury. Attach handle with setscrew and provide manufacturer's recommended gravel fill around drain hole. Center post hydrant in a 2 ft - O inch x 2 ft - O inch x 5 inch thick concrete pad unless hydrant is mounted within a concrete slab, walk, etc.
3. V950: Automatic freeze protection valves shall be ¾-inch and shall have type 304 stainless steel bodies. Valves shall have screwed ends rated 150-pound WOG. Valve shall fully open at the ambient temperature of 35 degrees F and shall fully close as the liquid temperature rises. The valve shall fully close at an internal liquid temperature of 45 degrees F. Valves shall be Ogontz Series F; or equal.

2.09 ELECTRIC OPERATORS

A. Electric type operators shall include the motor, operator unit gearing, limit switches, torque switches, declutch lever, axillary handwheel, reversing starter, switches, mechanical position indicator, and accessories as indicated in the Valve Schedule, Table II. The valve actuator motor and all electrical enclosures shall be suitable for NEMA 4 Areas, as a minimum unless otherwise indicated in the valve schedule. A hammer blow mechanism that travels sufficiently enough to allow the motor to reach full speed before imparting a hammer blow to start valve in motion in either the closing or opening direction shall be incorporated when specified in the Schedule. The power gearing shall consist of helical gears of heat-treated steel, and worm gearing of hardened alloy steel. The gearbox enclosure shall be cast aluminum. All power gearing shall be grease lubricated with high speed parts on antifriction bearings. It shall be possible to remove the motor operator from the valves without taking the valve out of service. Actuating speed shall be as specified in the Schedule. The responsibility for proper operation shall reside with the valve supplier.

1. Self-locking open/close type actuators shall operate the valve from fully open to fully closed positions, or the reverse, at the valve speed indicated on the Schedule. Actuators shall have LOCAL-REMOTE and OPEN-STOP-CLOSE hand switches. While in LOCAL, the actuator shall be controlled by the OPEN-STOP-CLOSE hand switch. While in REMOTE, open/close valves shall be controlled by one open and one close remote isolated contact closure each rated for 2 amps, 120 volts, ac continuous. Power through the contact shall be 120 volts ac provided by the actuator. While the open contact is closed, the valve shall open. While the close contact is closed, the valve shall close. While neither contact is closed, the valve shall remain in its last position.
2. Modulating type actuators shall be provided with a Local/Remote selection switch when specified. Provide OPEN-STOP-CLOSE hand switches for local control. In remote control, actuators shall respond to an externally generated 4 to 20 Ma positioning signal. Input shall be isolated and impedance shall not exceed 300 ohms. The actuator shall go to the position corresponding to the input signal with integral position feedback control. The 4 Ma signal shall correspond to fully closed; 20 Ma signal shall correspond to fully open. When specified in the Valve Schedule, modulating type actuators shall be provided with position transmitter. The transmitter shall generate a 4 -20 mA signal into a 600 ohm load minimum that is linearly proportional to position with 4 mA corresponding to fully closed and 20 mA corresponding to fully open.

B. Motors shall be suitable for NEMA 4 with a maximum continuous temperature rating of 120 degrees C, unless otherwise indicated in the valve schedule. Available operating torque shall be at least two times the valve manufacturer's maximum torque requirements. The motor shall be of sufficient size to open or close a valve against the maximum specified differential pressure when voltage to the motor is $\pm$ 10% of nominal voltage. Electrical service to the motor shall be 3 phase, 60 HZ, 460 volts unless otherwise noted in the Valve Schedule. The motor shall be prelubricated and all bearings shall be of the anti-friction type. Motor rating shall be 30 minute duty.

C. Controls. Each actuator shall be equipped with a reversing starter, control relays, position limit switches, and torque limiting switches. Also, when specified in the Schedule, any or all of the following shall be included: open-close-stop pushbutton switches, local/remote selection switch, position transmitter, position indicating lights, electric braking and/or a position controller for the specified analog signal input. Enclosures shall be NEMA 4.

D. Reversing starter shall consist of a reversing contactor for each unit, mechanical and electrical interlock, and thermal overload relays as required. Contractor shall break all lines to the motor. All controls will operate on 120 VAC.

E. The actuators shall be equipped with four automatic double-acting geared limit switches and double-acting torque switches. Limit switches shall be geared directly to the operating gear train and shall be of the adjustable type capable of being adjusted to trip at any point between Fully Open and Fully Closed valve positions. Torque switches shall operate during the complete valve cycle to protect the valve from excessive loads met by obstructions in either direction of travel.

F. Manual operation shall be provided by a handwheel: The handwheel shall not rotate during electric operation nor shall a fused motor prevent manual operation. When in manual operating position, the unit shall automatically return to electric operation when the motor is energized. The transfer from motor operation to manual operation shall be accomplished by a positive declutching lever, which

will disengage the motor mechanically but not electrically. Handwheels shall be geared such that manual operation shall required no more than 30 lbs. of rim effort at a maximum required torque.

G. Actuator Data and Documentation: Supplier shall specify motor currents at the specified voltage for each actuator, corresponding to locked rotor current, maximum seating torque, average running load and speed. Supplier shall give full information concerning actuator dimensions and weights. The actuator nameplate shall be of corrosion resistant material and shall include serial number, actuator type, voltage, motor locked rotor and average load currents at the voltage for which the motor is connected. Each actuator shall be supplied with a start-up kit including wiring diagram and start-up instructions in the terminal housing, together with spare cover O-rings or gaskets and cover screws to make good site losses.

H. Mounting: Special mounting requirements such as shaft and neck extensions, etc., shall be provided as shown in the Schedule.

I. Coordination with Instrumentation: It shall be the responsibility of the Contractor to coordinate the actuator supplier with all sub-contractors to insure compatibility of control interfacing and the required operations.

J. Manufacturer: Electric valve actuators shall be as manufactured by Limitorque, Raymond Control Systems, AUMA, EIM, Worcester or approved equal.

K. Valves: The valves shall be of the type specified in the Schedule and in accordance with this Section.

2.10 PROTECTIVE COATINGS FOR VALVES

A. Interior. Two coats of factory-applied asphaltic varnish suitable for potable water applications, or Factory applied heat-cured epoxy coating conforming to AWWA C550.

B. Exterior. One coat of factory applied epoxy primer conforming to Section 09900, Painting for exposed valves (System No. 5); one coat of epoxy for buried valves (System No. 2). Field coat valves in conformance with referenced Systems detailed in Section 09900, Painting.

2.11 PRESSURE SENSORS

A. Line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the gauging mechanisms.

B. The sensor body shall be full line size, constructed of carbon steel and mounted in-line as shown on the Drawings. The sensor body shall be constructed with ANSI 125 pound flange connections, or in a wafer body design to fit between ANSI 125 pound flanges.

C. The manufacturer shall provide the sensor complete with gauges, pressure switches, or other accessories as shown on the Drawings and herein specified.

D. Captive liquid chamber shall be factory-filled; provide fill and bleed valves for field filling.

2.12 PRESSUES GAUGES

Pressure gages shall have bronze or stainless steel bourdon tube elements. Lens shall be heavy glass, with oil-resistant gasket seal. The dial shall be a minimum of 4.5-inches in diameter, with white coated metal lithographed with black metal graduations and numerals. The mounting as required. Connection shall be ¼-inch NPT with square wrench surface. Provide cartridge snubber and polished brass gauge cock. Range shall be as shown on the Drawings. Accuracy shall be plus or minus 0.5 percent.

2.13 TAPPING SLEEVES AND VALVES

A. Tapping Sleeves: Provide caulked type sleeves, suitable for use on both ductile iron and steel pipe, in the sizes shown on the Drawings.

B. Tapping Valves: Provide valves of the mechanical joint type with "O" ring seals, in the sizes shown on the Drawings.

2.14 VALVE BOXES (VB)

Valve boxes shall be adjustable cast iron.

PART 3 - EXECUTION

3.01 INSTALLATION

Installation shall be in conformance with Section 15060, Piping and Appurtenances and the following requirements.

Above ground Valves shall be rigidly held in place using supports and hangers as shown on the drawings and 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 galvanized anchor bolts.

3.02 TESTS

A. Shop and Laboratory Tests. Perform shop and laboratory tests on valves and appurtenances as follows:

1. Wedge Gate Valves. Perform shop tests for leakage in accordance with AWWA C500, except no leakage shall occur with design pressure held for one minute.
2. Butterfly valves. The following applies to all sizes specified from 3 inch diameter to 48 inch diameter.
    a. Material Tests. Physical and chemical properties tests shall be performed on all material

components to be used in manufacture of butterfly valves in accordance with AWWA C504-80, Section 2, including valve sleeve bearing materials.

b. Gear Operator Tests. Manufacturer shall test each model of gear operator and establish torque rating curves in accordance with AWWA C504-80, Section 3.8.

c. Performance Tests. Manufacturer shall shop test each butterfly valve for performance, leakage, and hydrostatic pressure in accordance with Section 5 of AWWA C504-80. Manufacturer shall submit valve size and class. If no recent test data is available for valve size and class to be furnished under these Specifications, manufacturer shall perform hydrostatic and cycle tests of said Section 5.4 and 5.5.

B. 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.

3.03 COORDINATION WITH INSTRUMENTATION

It shall be the responsibility of the Contractor to coordinate with Division 11, Division 13, Division 16, and the Distributed Control System regarding the requirements of control valves.

3.04 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

The installation and operation of the valve and motorized actuators shall be the unit responsibility of the valve supplier.

3.05 CLEANING

All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other sections.

3.06 ISOLATION VALVES

A line size ball valve and union shall be installed upstream of each solenoid valve for isolation during maintenance.

3.07 ACCESS DOORS

Location of valves shall be as required to provide accessibility for control and maintenance. Furnish access doors in finished walls and plaster ceilings where necessary for valve access.

3.08 ANCHOR BOLTS

Anchor bolts for floor stands, stem guides, etc. shall be in accordance with Sections 01600, General Material and Equipment Requirements and 15050.

TABLE I
DISTRIBUTION VALVE SCHEDULE

TAG NUMBERS	SERVICE	TYPE	SIZE
DV-15	Discharge Manifold	Ball Valve	36"
DV-15A	Discharge Manifold	Ball Valve	36"
DV-16	Discharge Manifold	Ball Valve	36"
DV-17	Discharge Manifold	Ball Valve	36"
DV-18	Discharge Manifold	Ball Valve	36"
DV-19	Discharge Manifold	Ball Valve	36"
DV-19A	Discharge Manifold	Ball Valve	36"
DV-20	Discharge Manifold Bypass	Ball Valve	36"
DV-21	Check Valve Isolation	Butterfly Valve	24”
DV-22	Check Valve	Swing Check Valve	24”
DV-23	Check Valve Isolation	Butterfly Valve	24”
DV-24	Check Valve Bypass	Butterfly Valve	24”
DV-26	Check Valve Isolation	Butterfly Valve	16”
DV-27	Check Valve	Swing Check Valve	16”
DV-28	Check Valve Isolation	Butterfly Valve	16”
DV-29	Check Valve Bypass	Butterfly Valve	16”
DV-30	Check Valve Isolation	Butterfly Valve	24”
DV-31	Check Valve	Swing Check Valve	24”
DV-32	Check Valve Isolation	Butterfly Valve	24”
DV-33	Check Valve Bypass	Butterfly Valve	24”
DV-34	Check Valve Isolation	Butterfly Valve	24”
DV-35	Check Valve	Swing Check Valve	24”
DV-36	Check Valve Isolation	Butterfly Valve	24”
DV-37	Check Valve Bypass	Butterfly Valve	24”

TABLE II
MOTORIZED VALVE SCHEDULE

TAG NUMBERS	SERVICE	TYPE	SIZE
RCV-7	Distribution System	Ball Valve	24”
RCV-9A	Airport Service Pipe	Ball Valve	24”

+ + + END OF SECTION 15100 + + +

SECTION 16050
BASIC ELECTRICAL MATERIAL AND METHODS

PART 1 - GENERAL

1.01 SCOPE

This Section covers basic materials and methods not included in other Sections of Division 16.

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 INDIVIDUAL MOTOR STARTERS

A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch for fractional sizes.

B. Magnetic Starters: NEMA ICS-2 Type A; NEMA size 1 minimum; magnetically held contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starters shall be rated and sized in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.

C. Magnetic Starter Controls: All controls, unless otherwise noted or shown, shall be 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter and overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one (1) spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off-auto selector switch and other controls as indicated.

D. Combination Starters: Molded case circuit breaker rated 42,000 amps.

E. Acceptable Manufacturers: General Electric, Square D, Allen Bradley, Siemens, Westinghouse or equal.

2.02 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.

2.03 TERMINAL JUNCTION BOXES (TJB)

Provide hinged-cover terminal junction boxes of the required type and size where indicated. Utilize enclosures as required in 16000-2.01. 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.

2.04 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 CR 104P, 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.

2.05 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.

2.06 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 2. 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.

2.07 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.

2.08 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.

2.09 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 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; 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; Westinghouse MCP; Square D Mag-Guard; or equal.

2.10 SUPPORTING DEVICES

A. Support Channel: Fiberglass, according to 16000-2.01

B. Hardware: Stainless steel, according to 16000-2.01.

2.12 ELECTRICAL IDENTIFICATION

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Wire and Cable Markers: Plastic, split sleeve or tubing type.

2.13 PLYWOOD BACKBOARDS

Backboards: Grade BC plywood, ¾-inch thick. Paint with two coats of flat black paint.

PART 3 - EXECUTION

3.01 INDIVIDUAL MOTOR STARTERS

A. Select and install heater elements in motor starters to match installed motor characteristics. Do not use NEC motor full load ampere data for heater selection.

B. Provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data. Provide an engraved nameplate on the exterior of the enclosure door identifying the motor served, the horsepower, voltage, and phase rating.

C. Enclosure type, unless otherwise indicated, enclosures shall be according to Section 16000-2.01.

D. Install starters so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a non-flammable backboard secured to the studs with the starter secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal ½ inch separation from concrete walls in wet or damp locations.

3.02 FUSES

Equip all fusible devices with fuses. Replace all blown fuses up to final acceptance of the Project. At the completion of the Project, turn over to the Owner spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

3.03 TERMINAL JUNCTION BOXES (TJB)

Install in accordance with all the requirements detailed under Section 16130, BOXES. Label each block and terminal with a permanently attached, nondestructible tag.

3.04 SUPPORTING DEVICES

A. Fasten hanger rods, support stands, conduit clamps, etc. to building structure using approved material.

B. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Do not use powder actuated fastening devices. Do not drill structural steel members.

3.05 ELECTRICAL IDENTIFICATION

Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters, and other items of electrical distribution equipment. Engrave with the equipment identification as indicated, and the voltage rating. Attach nameplates with screws or rivets; adhesives are not acceptable.

+++ END OF SECTION 16050 +++

SECTION 16110
RACEWAYS, BOXES, AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE

This section covers the furnishing and installation of electrical conduits, wireways, pull boxes, manholes, handholes, cable trays, fittings and supports. Raceways shall be provided for lighting, receptacles, power, control, instrumentation, signaling and grounding systems.

1.02 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

1.03 SUBMITTALS

The following information shall be provided in accordance with the General Conditions:

1. Manufacturer's descriptive literature for all materials.
2. 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

2.01 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 outdoors shall be provided with neoprene gaskets on the hinged doors or removable covers. 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.

2.02 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.

2.03 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.

2.04 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".

2.05 NAMEPLATES

Nameplates shall be provided for all boxes in accordance with the requirements of Section 16050, Basic Electrical Material and Methods. 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.

2.06 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.

2.07 RACEWAY IDENTIFICATION

Raceway number tags shall conform to the requirements of raceway markers, Section 16050, Basic Electrical Material and Methods.

PART 3 - EXECUTION

3.01 CONDUIT

A. GENERAL:

The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

Conduit runs shall be limited to a maximum of 400 feet between pull boxes, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

B. INDOOR AND OUTDOOR CONDUIT SYSTEMS:

In general, conduit inside structures shall be concealed unless otherwise specified or indicated on the drawings. No conduit shall be exposed in water chambers unless so indicated on the drawings.

Unless otherwise indicated on the drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements set forth herein.

Conduit installation shall conform to the following:

1. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.
2. Two or more exposed conduits in the same general routing shall be in parallel with symmetrical bends.
3. Exposed conduit shall be run on supports spaced not more than 10 feet apart.

4. Where three or more conduits are located in parallel run, they shall be spaced out from the wall using framing channel.
5. Conduits support systems shall comply with the requirements of Section 16050, Basic Electrical Material and Methods.
6. Conduit rack supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors or framing channel concrete inserts.
7. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues with temperatures higher than 90 degrees C.
8. 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.
9. Conduit shall be routed clear of structural openings and indicated future openings.
10. Conduits through roofs or metal walls shall be flashed and sealed watertight.
11. Conduit shall be neatly grouted into any openings cut into concrete and masonry structures.
12. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.
13. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.
14. Concealed conduit stubup locations shall be determined from the manufacturer's shop drawings.
15. Concealed conduit for future use shall be terminated in equipment or by galvanized couplings plugged flush with structural surfaces.
16. Where the drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.
17. Conduit installed horizontally shall allow headroom of at least 7 feet except where it may be installed along structures, piping, and equipment, or in other areas where headroom cannot be maintained because of other considerations.
18. All conduits that enter enclosures shall be terminated by fittings which ensure that the NEMA rating of the enclosure is not affected or changed.
19. Underground metallic or nonmetallic conduit which turns out of concrete, masonry or earth shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before emergence.
20. Conduit across structural joints where structural movement is allowed shall have an O-Z "Type DX" or Crouse-Hinds "Type XD," bonded, weathertight expansion and deflection fitting of that conduit size.

C. UNDERGROUND CONDUIT SYSTEM:

All excavation, backfilling, and concrete work shall conform to respective sections of these specifications. Underground conduit shall conform to the following requirements:

1. All underground conduits not indicated otherwise on the drawings shall be concrete encased. All concrete encasement shall be reinforced.
2. Concrete encased conduit shall have minimum concrete thicknesses of 3 inches between conduits, 1 inch between conduit and reinforcing, and 3 inches over reinforcing.
3. Concrete encasement on exposed outdoor conduit risers shall continue to 3 inches above grade, with top crowned and edges chamfered.
4. Underground conduit bend radius shall be not less than 2 feet minimum at vertical risers nor less than 3 feet elsewhere.
5. Where conduit and concrete encasement are terminated underground, the conduit and reinforcing shall both extend at least 2 feet past the concrete. Conduits shall be capped and threads shall be protected. All steel surfaces shall be given two coats of thixotropic coal tar paint.
6. Underground conduits and conduit banks shall have 2 feet minimum earth cover except where indicated otherwise.
7. Underground conduit banks through building walls shall be cast in place or concreted into boxouts with waterstops on all sides of the boxout. Waterstops shall be as specified in the Cast-in-Place Concrete section.
8. Conduits not encased in concrete and passing through walls which have one side in contact with earth shall be sealed watertight with special rubber gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
9. Conduits shall be thoroughly swabbed on the inside, immediately upon completion of pouring concrete. After the concrete has set, and before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. If the mandrel showed signs of protrusions on the inside of the conduit, the conduit shall be repaired or replaced.
10. All spare raceways shall be provided with a nylon pull rope.

D. SEALING OF CONDUIT:

Conduits passing from a hazardous or corrosive area into a nonhazardous or noncorrosive area, or between Class 1, Division 1 area and Class 1, Division 2 area shall be provided with a sealing fitting which shall be located at the boundary in accordance with NEC.

Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized cast ferrous alloy. Sealing compound shall be hard type, UL listed for explosion proof sealing fittings. Sealing compound shall be nonhardening type for corrosive areas. Seal fitting and sealing compound shall be as manufactured by Appleton, Crouse-Hinds, or equal.

3.02 MANHOLES AND HANDHOLES

Unless otherwise specified, manhole and handhole installation shall be as follows:

1. Manholes and handholes shall be set on a minimum of 6 inches of crushed rock on top of undisturbed or compacted earth.
2. Manholes and handholes shall be set plumb, so that water shall drain properly to the sump.
3. 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.
4. 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.

3.03 CABLE TRAY

Unless otherwise specified, cable tray installation shall be as follows:

1. Cable trays shall be supported at intervals not to exceed 5 feet.
2. Corners shall be supported by two supports installed as close as possible to the corner, with one support on each side of the corner.
3. All field cuts shall be treated with zinc rich paint.
4. Expansion joint splice plates shall be used to allow 1 1/2-inch free movement between adjacent trays when crossing building expansion joint.
5. Cable tray shall have minimum clearance of 3/4 inch from concrete surfaces and minimum spacing of 12 inches from other trays. The top of the tray shall be minimum 9 inches from the ceiling.
6. Signal cable trays shall be provided with covers. Covers shall be solid or louvered type.
7. Each cable tray shall be provided with No. 2/0 AWG minimum bare copper equipment ground conductor. The ground conductor shall be attached to the outside of each tray section using UL Listed bolted bronze or brass ground clamp.
8. Power cables shall be placed in cable trays not more than two layers deep.
9. Cables shall be arranged in trays so as to provide minimum cross-over.

3.04 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.

3.05 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 16110 +++

SECTION 16111
CONDUIT

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of 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.

1.02 SUBMITTALS

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

1. Equipment data specified in this Section.
2. Catalog cuts.

1.03 QUALITY ASSURANCE

Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C80.1
2. ASTM F 512
3. Fed Spec WW-C-581E
4. Fed Spec WW-C-1094A
5. NEMA TC2
6. NEMA TC6
7. NFPA 70
8. UL 1
9. UL 6
10. UL 360
11. UL 651

1.04 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

2.01 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.

2.02 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.

2.03 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.

2.04 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.

2.05 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.

2.06 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.

2.07 PRECAST HANDHOLES AND MANHOLES

A. Install handholes and manholes with 28-day, 2,500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for handholes and manholes are shown on the Drawings. Increase these as required by use of extension sections to accommodate the several raceway entrances at their required elevations.

B. Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide a drainage outlet at the low point of the floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

C. Provide raceway entrances on all four sides. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.

D. For manholes, utilize heavy-duty type frames and covers made of stainless steel, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burn

by welder, in integral letters not less than 2 inches high appropriate titles, ELECTRIC HV (for above 600 volts), ELECTRIC LV (for 600 volts and below), or COMMUNICATION. Field stamp covers with handhole and manhole numbers indicated on the Drawings.

E. For handholes, frames and covers shall conform to ASTM A48-83 and shall be slab type with letters as indicated above.

F. Provide heavy weight cable racks with adjustable arms and acceptable insulators for all cables in each handhole and manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the handhole, including spares.

G. Provide pulling irons. Utilize ¾-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.

H. Utilize handhole and manhole hardware of steel, hot-dip galvanized after fabrication.

I. Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc.; or equal.

2.08 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.

2.09 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

3.01 CONDUIT SCHEDULE

A. Use rigid steel conduits for indoor clean area.

B. Use liquidtight flexible steel conduit for connections to motors, transformers, and other vibrating equipment.

C. Non-jacketed flexible steel conduit may be used for connections to lighting fixtures in suspended ceilings.

D. Use PVC coated conduits where conduits are in direct contact with earth or where conduits

are installed in corrosive areas.

E. Use PVC conduits where conduits are embedded in concrete structures, encased in concrete duct bank or concealed in concrete block CMU.

F. 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.

3.02 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.

3.03 CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipecutter 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.

B. 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.

C. The maximum length between pull points is 400 feet. This length shall be reduced by 100 foot for each 90 degree of bend.

D. 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.

E. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.

G. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box.

H. Provide a 200 pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

I. Install expansion joints where conduit crosses building expansions joints and for straight runs in excess of 100 feet.

J. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

K. 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.

L. Provide clamp backs for conduits on exterior or damp surfaces to prevent the raceway from bearing directly on the damp surface.

M. Route conduits in slabs above the bottom reinforcing and below the top reinforcing. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.

N. PVC conduit bends: Use PVC-coated rigid steel factory elbows.

O. 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.

P. Provide sealing compound equal to Chico A or Chico B where conduit passes from hazardous or corrosive area in to a nonclasified area.

Q. Each conduit shall be provided with a number tag at each end.

3.04 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.

3.05 HANDHOLES AND MANHOLES

A. Install handholes and manholes where shown on the Drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified in Division 2 of these Contract Documents.

B. Do not install handholes or manholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.

C. Install one ground rod in each handhole and/or manhole. Connect all noncurrent-carrying metal parts in the manhole or handhole and any metallic raceway grounding bushings to this ground rod with No. 6 AWG (minimum) copper conductor.

+++ END OF SECTION 16111 +++