# SPECIFICATIONS

# AND

# CONTRACT DOCUMENTS

# FOR

# KENTUCKY AMERICAN WATER
# RICHMOND ROAD STATION WTP
# IMPROVEMENTS

## JUNE 2014

## 60% Submittal

## VOLUME 1 OF 1

HAZEN AND SAWYER
Environmental Engineers & Scientists

**KENTUCKY AMERICAN WATER**

# CONTRACT DOCUMENTS AND SPECIFICATIONS

**FOR**

# RICHMOND ROAD STATION WTP IMPROVEMENTS

**June 2014**


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**KENTUCKY AMERICAN WATER**
**RICHMOND ROAD STATION WTP IMPROVMENTS**

SECTION 00003

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SECTION 01400

QUALITY CONTROL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Testing Laboratory Services

1. Laboratory testing and checking required by the Specifications, including the cost of transporting all samples and test specimens, shall be provided and paid for by the Contractor unless otherwise indicated in the Specifications.

2. Materials to be tested include, but are not necessarily limited to the following: cement, concrete aggregate, concrete, bituminous paving materials, structural and reinforcing steel, waterproofing, select backfill, crushed stone or gravel and sand.

3. Tests required by the Owner shall not relieve the Contractor from the responsibility of supplying test results and certificates from manufacturers or suppliers to demonstrate conformance with the Specifications.

4. Procedure

a. The Contractor shall plan and conduct his operations to permit taking of field samples and test specimens, as required, and to allow adequate time for laboratory tests.

b. The collection, field preparation and storage of field samples and test specimens shall be as directed by the Engineer with the cooperation of the Contractor.

5. Significance of Tests

a. Test results shall be binding on both the Contractor and the Owner, and shall be considered irrefutable evidence of compliance or noncompliance with the Specification requirements, unless supplementary testing shall prove, to the satisfaction of the Owner, that the initial samples were not representative of actual conditions.

6. Supplementary and Other Testing

a. Nothing shall restrict the Contractor from conducting tests he may require. Should the Contractor at any time request the Owner to consider such test results, the test reports shall be certified by an independent testing laboratory acceptable to the Owner. Testing of this nature shall be conducted at the Contractor 's expense.

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1.02 WATERTIGHTNESS OF STRUCTURES

A. It is the intent of these Specifications that all concrete work and sealing work around built-in items and penetrations be performed as required to insure that groundwater, surface water, and water or liquids in tanks, channels and containers will not intrude into any equipment rooms, pipe galleries, habitable areas or other generally dry areas.

B. The required watertightness shall be achieved by quality concrete construction and proper sealing of all joints and penetrations.

C. Each unit shall be tested separately and the leakage tests shall be made prior to backfilling and before equipment is installed. Testing water shall be from any potable, non-potable, or natural moving source such as a river or stream, but not from any still water source such as a lake or pond, and not from any wastewater source.

D. All water holding structures shall be tested for leakage by the Contractor. The Contractor shall provide at his own expense all labor, material, temporary bulkheads, pumps, water measuring devices, etc., necessary to perform the required tests.

E. Hydrostatic Testing

1. The design capability of the structure to withstand testing shall be verified for the pressures to be applied. Another type of test shall not be substituted for hydrostatic testing without approval of the Engineer.

2. The structure shall not be tested before the concrete has attained its specified compressive strength.

3. Clean the exposed concrete surfaces of the structure, including the floor, of all foreign material and debris. Prior to testing, standing water inside of the structure that would interfere with the observation of the exposed concrete surfaces of the structure shall be removed. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. All openings, fittings, and pipe penetrations in the structure shell shall be inspected at both faces of the concrete, if practical. Defective or cracked concrete shall be repaired prior to testing.

4. All structural penetrations and outlets shall be securely sealed to prevent the loss of water from the structure during the test. All structural penetrations shall be monitored before and during the test to determine the watertightness of these appurtenances. Leakage at these outlets shall be repaired prior to testing. No allowance shall be made in test measurements for uncorrected known points of leakage.

5. The ground water level shall be brought to a level below the top of the base slab and kept at that elevation or at a lower elevation during the test.

6. The initial filling of a new structure should not exceed a rate of 4 ft/h. Filling shall be continued until the water surface is at 4 in. below the top section. The exterior surfaces of the structure shall be inspected during the period of filling the structure. If any flow of water is observed from the structure exterior surfaces, including joints or cracks, the defect causing the leakage shall be repaired prior to testing.

7. The water shall be kept at the test level for at least 24-hours prior to testing.

8. The test measurements shall not be scheduled for a period when the forecast is for a substantial change in the weather pattern. The test shall also not be scheduled when the weather forecast indicates the water surface would be frozen before the test is completed. A restart of the test shall be required when test measurements become unreliable due to unusual precipitation or other weather factors.

9. The vertical distance to the water surface shall be measured from a fixed point on the structure above the water surface. Measurements shall be recorded at 24-hour intervals.

10. The test period shall be at least the theoretical time required to lower the water surface 3/8 in. assuming a loss of water at 0.050% of the water volume per 24-hour period. The test period shall not be longer than five days.

11. The water temperature shall be recorded at a depth of 18 in. below the water surface.

12. A floating, restrained, partially filled, calibrated, open container for evaporation and precipitation measurement should be positioned in open structures and the water level in the container recorded at 24-hour intervals.

13. The allowable loss of water for tightness tests shall not exceed 0.050% of the test water volume in 24 hours.

14. The change in water volume in the structure shall be calculated and corrected, if necessary, for evaporation, precipitation, and temperature based on the change recorded in the water level from the open container. If the loss exceeds the allowable loss, the structure shall be considered to have failed the test. Observed flow or seepage of water from the exterior surface, including that from cracks and joints, should be considered as a failed test. The structure shall also be considered to have failed the test if moisture can be transferred from the exterior surface to a dry hand. Dampness or wetness on top of a footing shall not be considered as a failure test.

15. The Contractor r shall be permitted to immediately retest when no visible leakage is exhibited. If the structure fails the second test or if the Contractor does not exercise the option of immediately retesting after the first test failure, the interior of the structure shall be inspected by a diver or by other means to determine probable areas of leakage. The structure shall only be retested after the most probable areas of leakage are repaired.

16. If the leakage exceeds the allowable limit, the work shall be corrected by methods approved by the Engineer.

17. Upon completion of the necessary remedial work, the leakage test shall be repeated until it is successfully passed.

F. Notification by Engineer

If any leaks, in excess of the specified amount, are not remedied by the Contractor within four (4) weeks of notification by the Engineer, regardless of whether the cause of these leaks is or is not determined, the Engineer shall have the authority to have these leaks repaired by others. The cost of repairs, by others, shall be deducted from monies due or to become due to the Contractor.

1.03 FIELD TESTING OF EQUIPMENT

A. All equipment shall be set, aligned and assembled in conformance with the manufacturer's drawings and instructions.

B. Preliminary Field Tests, Yellow Tag

1. As soon as conditions permit, after the equipment has been secured in its permanent position, the Contractor shall check the equipment for alignment, direction of rotation and that it is free from defects.

2. Contractor shall flush all bearings, gear housings, etc., in accordance with the manufacturer's recommendations, to remove any foreign matter accumulated during shipment, storage or erection. Lubricants shall be added as required by the manufacturer's instructions.

3. When the Contractor has demonstrated to the Engineer that the equipment is ready for operation, a yellow tag will be issued. The tag will be signed by the Engineer, or his assigned representative and attached to the equipment. The tag shall not be removed.

4. Preliminary field tests, yellow tag, must be completed before equipment is subjected to final field tests, blue tag.

C. Final Field Tests, Blue Tag

1. Upon completion of the installation, and at a time approved by the Engineer, equipment will be tested by operating it as a unit with all related piping, ducting, electrical controls and mechanical operations.

2. The equipment will be placed in continuous operation as prescribed or required and witnessed by the Engineer or his assigned representative and the Owner or his assigned representative.

3. The tests shall prove that the equipment and appurtenances are properly installed, meet their operating cycles and are free from defects such as overheating, overloading, and undue vibration and noise. Equipment shall be tested for the characteristics as specified for the item.

4. Each pump shall be tested at maximum rated speed for at least four points on the pump curve for capacity, head and electric power input. The rated motor nameplate current and power shall not be exceeded at any point within the specified range. Vibrometer readings shall be taken when directed by the Engineer and the results

recorded. Additional tests shall be performed as prescribed in other sections of the Specifications.

5. Pumps with drive motors rated at less than five horsepower shall only be tested for excess current or power when overheating or other malfunction becomes evident in general testing.

6. Until final field tests are acceptable to the Engineer, the Contractor shall make all necessary changes, readjustments and replacements at no additional cost to the Owner.

7. Defects which cannot be corrected by installation adjustments will be sufficient grounds for rejection of any equipment.

8. Upon acceptance of the field tests, a blue tag will be issued. The tag will be signed by the Engineer and attached to the unit. The tag shall not be removed and no further construction work will be performed on the unit, except as required during start-up operations and directed by the Engineer.

9. All costs in connection with such tests including all materials, equipment, instruments, labor, etc., shall be borne by the Contractor.

1.04 IMPERFECT WORK, EQUIPMENT, OR MATERIALS

A. Any defective or imperfect work, equipment, or materials furnished by the Contractor which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be removed immediately even though it may have been overlooked by the Engineer and estimated for payment. Any equipment or materials condemned or rejected by the Engineer shall be tagged as such and shall be immediately removed from the site. Satisfactory work or materials shall be substituted for that rejected.

B. The Engineer may order tests of imperfect or damaged work, equipment, or materials to determine the required functional capability for possible acceptance, if there is no other reason for rejection. The cost of such tests shall be borne by the Contractor; and the nature, tester, extent and supervision of the tests will be as determined by the Engineer. If the results of the tests indicate that the required functional capability of the work, equipment, or material was not impaired, consistent with the final general appearance of same, the work, equipment, or materials may be deemed acceptable. If the results of such tests reveal that the required functional capability of the questionable work, equipment, or materials has been impaired, then such work, equipment, or materials shall be deemed imperfect and shall be replaced. The Contractor may elect to replace the imperfect work, equipment, or material in lieu of performing the tests.

1.05 INSPECTION AND TESTS

A. The Contractor shall allow the Engineer ample time and opportunity for testing materials and equipment to be used in the work. He shall advise the Engineer promptly upon placing orders for material and equipment so that arrangements may be made, if desired, for inspection before shipment from the place of manufacture. The Contractor shall at all times furnish the Engineer and his representatives, facilities including labor, and allow proper time for inspecting and testing materials, equipment, and workmanship. The Contractor must

anticipate possible delays that may be caused in the execution of his work due to the necessity of materials and equipment being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the Engineer for testing, and shall make his own arrangements for providing water, electric power, or fuel for the various inspections and tests of structures and equipment.

B. The Contractor shall furnish the services of representatives of the manufacturers of certain equipment, as prescribed in other Sections of the Specifications. The Contractor shall also place his orders for such equipment on the basis that, after the equipment has been tested prior to final acceptance of the work, the manufacturer will furnish the Owner with certified statements that the equipment has been installed properly and is ready to be placed in functional operation. Tests and analyses required of equipment shall be paid for by the Contractor, unless specified otherwise in the Section which covers a particular piece of equipment.

C. Where other tests or analyses are specifically required in other Sections of these Specifications, the cost thereof shall be borne by the party (Owner or Contractor) so designated in such Sections. The Owner will bear the cost of all tests, inspections, or investigations undertaken by the order of the Engineer for the purpose of determining conformance with the Contract Documents if such tests, inspection, or investigations are not specifically required by the Contract Documents, and if conformance is ascertained thereby. Whenever nonconformance is determined by the Engineer as a result of such tests, inspections, or investigations, the Contractor shall bear the full cost thereof or shall reimburse the Owner for said cost. In this connection, the cost of any additional tests and investigations, which are ordered by the Engineer to ascertain subsequent conformance with the Contract Documents, shall be borne by the Contractor.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01520

MAINTENANCE OF UTILITY OPERATIONS DURING CONSTRUCTION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The intent of this section is to outline the minimum requirements necessary to provide continuous treatment and disinfection of the finished water flow throughout the construction period.

1.02 GENERAL CONSTRAINTS

A. Existing plant operation will be continuously maintained by the Owner during the entire construction period. Construction work will be scheduled and conducted by the Contractor so as not to impede any treatment process, reduce the quality of the finished water, or other nuisances. In performing the work, the Contractor will plan and schedule his work to meet plant and distribution system operating requirements and the constraints and construction requirements as outlined below.

B. The Contractor shall coordinate the general construction as well as the electrical and Instrumentation, HVAC, and plumbing construction schedules. Permanent or temporary power will be available for all existing, proposed, and temporary facilities that are required to be on line at any given time. The Contractor will also provide additional temporary facilities, if needed, to eliminate a constraint and maintain continuous and dependable plant operation.

C. All treatment processes will be maintained in continuous operation during the construction period except during approved process interruptions. All system or partial system shutdowns and diversions will be approved, coordinated, and scheduled at times suitable to the Owner. Shutdowns will be fully coordinated with the Owner at least 7 days before the scheduled shutdown. Shutdowns will typically be scheduled for weekend or midnight low flow periods and will be limited depending on distribution system flow rate demand and storage volume in the distribution and treatment systems. The duration of shutdowns will be at the discretion of the Owner. Further, the Owner will have the authority to order work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the plant operations.

D. Shutdowns will not begin until all required materials are on hand and ready for installation. The Contractor shall proceed with the work continuously, start to finish, until the work is completed and normal plant operation is restored. Appropriate diversion facilities will be furnished when the plant cannot be shutdown for a sufficient period of time to accomplish the work. If the Contractor completes all required work before the specified shutdown period has ended, the Owner may immediately place the existing system back into service. In the event that plant operation is impaired, the Contractor will immediately make all repairs or replacements and do all work necessary to restore the plant to operation to the satisfaction of the Owner. Such work shall progress continuously to completion on a 24 hour-per-day, seven work days-per-week basis.

1.03 SPECIFIC OPERATIONAL CONSTRAINTS

A. Listed in this section are specific construction restraints and shutdowns required for the different project components. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements.

B. New facilities will consist of a filter building, chlorine contact tank and backwash tank, chemical feed vault, chemical feed modifications, new electrical distribution facilities and standby generator. The construction of new treatment facilities on the Richmond Road Station WTP site will not impact existing plant operation. The construction of the new filtration and chlorine contact facilities will be located on presently vacant land on the existing plant site. Coordination of non-essential utilities will be required during construction.

C. Installation of Tie-Ins to Existing Settled Water (SW) and Finished Water (FW) Piping

1. Connections to existing filter effluent shall be coordinated with the Owner and Engineer so as not to disrupt the flow from the existing Clearwell No. 1 to existing Clearwell No. 2. The connection to the filter effluent pipe will be made as shown on the Drawings. Connection to the existing settled water lines to feed the new filter building shall not disrupt flow between the settling basins and the existing filter building. Shut-down and tie-ins shall be completed per section 1.02, D.

D. Relocation of High Service Pump Yard Piping

1. Before construction of the chlorine contact and backwash tank begins, the existing 16-inch high service pump discharge main will be relocated around the footprint of the structure. The new line will be installed during construction as shown on the Drawings.

E. Relocation of Existing Blower

1. Following construction and startup of the new filter building, the Contractor will remove the existing air scour blower and enclosure near the existing filter building and relocate the blower and enclosure to the new filter building area. The relocated air scour blower will be connected to a new motor and new air supply header and serve as back up for the newly purchased and installed blower.

F. Chemical System Modifications

1. All chemical system modifications shall be coordinated with the Owner and Engineer to ensure that chemical feed to the existing application points is continuous, and feed to the existing and new application points can be provided simultaneously until construction of new facilities is complete and the feeds to existing facilities to be demolished can be discontinued.

E. Construction of Filter Building, Backwash Tank, and Associated Piping

1. When the filtration building is constructed and ready to be brought online, the backwash tank will be filled from the high service pumps, and the backwash pumps will be used to fill the filter backwash supply header, individual filter backwash supply piping and the individual filter underdrains and boxes. All lines will be flushed, disinfected, pressure tested, and bacteria tested for coliform, all in accordance with current AWWA standards, KDOW requirements, and the Contract Documents. The

backwash pumps will also provide the source water for backwashing and skimming the media as identified in the Contract Documents.

2. After disinfection is complete and the new facilities are in service, filtered water from the new filter building will be used to fill the CT basin and the backwash tank. The existing filter building will stay in operation and will also feed the clearwell until the new process is producing finished water. Chemical feed systems will be modified to temporarily feed to both the existing and new facilities during this transition time.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and Install

1. Where the words "furnish", "provide", "supply", "replace", or "install" are used, whether singularly or in combination, they shall mean to furnish and install, unless specifically stated otherwise.

2. In the interest of brevity, the explicit direction "to furnish and install" has sometimes been omitted in specifying materials and/or equipment herein. Unless specifically noted otherwise, it shall be understood that all equipment and/or materials specified or shown on the Drawings shall be furnished and installed under the Contract as designated on the Drawings.

B. Concrete Foundations for Equipment

1. Each Contractor shall provide all concrete foundations shown, specified or required for all equipment furnished under their respective Contract.

2. Anchor bolts and templates for equipment foundations shall be furnished under the respective Contracts for installation by the respective Contractor.

3. All concrete foundations for equipment shall be treated, by the respective Contractor, with an approved sealer to prevent oil from seeping into the concrete.

1.02 EQUIPMENT AND MATERIALS

A. All equipment, materials, instruments or devices incorporated in this project shall be new and unused, unless indicated otherwise in the Contract Documents. Equipment and materials to be incorporated into the work shall be delivered sufficiently in advance of their installation and use to prevent delay in the execution of the work, and they shall be delivered as nearly as feasible in the order required for executing the work.

B. The Contractor shall protect all equipment and materials from deterioration and damage, including provisions for temporary storage buildings as needed. Storage of equipment and materials shall be in locations completely protected from flooding, standing water, excessive dust, falling rock, brush fire, etc. Storage areas shall be located sufficiently distant from all construction activities and the movement of construction vehicles to minimize the potential for accidental damage. Any equipment or materials of whatever kind which may have become damaged or deteriorated from any cause shall be removed and replaced by good and satisfactory items at the Contractor's expense for both labor and materials.

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1.03 INSTALLATION OF EQUIPMENT

A. Equipment and materials shall be installed in accordance with the requirements of the General Conditions, Supplemental Conditions and the respective Specification Sections.

B. Concrete foundations for equipment shall be of approved design and shall be adequate in size, suitable for the equipment erected thereon, properly reinforced, and tied into floor slabs by means of reinforcing bars or dowels. Foundation bolts of ample size and strength shall be provided and properly positioned by means of suitable templates and secured during placement of concrete. Foundations shall be built and bolts installed in accordance with the manufacturer's certified drawings.

C. Before mounting equipment on a foundation, the Contractor shall clean the top surface; if necessary, rough it with a star chisel and clean again; and clean out all foundation bolt sleeves. The Contractor shall provide a sufficient number of steel plate shims about 2-inches wide and 4-inches long, and of a varying thickness from 1/8 to 1/2-inch. A combination of these shims shall be placed next to each foundation bolt to bring the bottom of the bedplate or frame about 1/8-inch above the final setting. The equipment shall be lowered by changing the combination of shims. Using brass shim stock of various thicknesses, continue to level the equipment a little at a time and in rotation until it is at the correct elevation in both directions. When the equipment is level, tighten down on the foundation bolts a little at a time in rotation to make certain the equipment remains level and does not shift on the shims. A preliminary alignment check shall be made before grout is placed.

D. Equipment shall be set, aligned and assembled in conformance with manufacturer's drawings or instructions. Run out tolerances by dial indicator method of alignment shall be plus or minus .002-inches, unless otherwise approved by the Engineer.

E. All blocking and wedging required for the proper support and leveling of equipment during installation shall be furnished by the Contractor. All temporary supports shall be removed, except steel wedges and shims, which may be left in place with the approval of the Engineer.

F. Each piece of equipment or supporting base, bearing on concrete foundations, shall be bedded in grout. The Contractor shall provide a minimum of 1-1/2-inch thick grouting under the entire baseplate supporting each pump, motor drive unit and other equipment. Grout shall be non-shrink grout, as specified under Section 03600, Grout.

G. When motors are shipped separately from driven equipment, the motors shall be received, stored, meggered once a month, and the reports submitted to the Engineer. After driven equipment is set, the motors shall be set, mounted, shimmed, millrighted, coupled and connected complete.

1.04 CONNECTIONS TO EQUIPMENT

A. Connections to equipment shall follow manufacturer's recommendations as to size and arrangement of connections and/or as shown in detail on the Drawings or approved Shop Drawings. Piping connections shall be made to permit ready disconnection of equipment with minimum disturbance of adjoining piping and equipment.

B. The Electrical Contractor shall be responsible for bringing proper electrical service to each item of equipment requiring electrical service as shown on the Drawings or approved Shop Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

C. The HVAC Contractor shall bring and connect HVAC service to all equipment items requiring same as shown on the Drawings. Electrical connections to equipment requiring electrical service shall be made by the Electrical Contractor, unless otherwise indicated on the Drawings or in the Technical Specifications.

D. The Plumbing Contractor shall bring and connect plumbing service to all equipment items requiring same as shown on the Drawings.

1.05 SUBSTITUTIONS

A. Requests for substitutions of equipment or materials shall conform to the requirements of the General Conditions, Supplemental Conditions, and as hereinafter specified.

1. Contractor shall submit for each proposed substitution sufficient details, complete descriptive literature and performance data together with samples of the materials, where feasible, to enable the Owner and Engineer to determine if the proposed substitution is equal.

2. Contractor shall submit certified tests, where applicable, by an independent laboratory attesting that the proposed substitution is equal.

3. A list of installations where the proposed substitution is equal.

4. Requests for substitutions shall include full information concerning differences in cost, and any savings in cost resulting from such substitutions shall be passed on to the Owner.

B. Where the approval of a substitution requires revision or redesign of any part of the work, including that of other Contracts, all such revision and redesign, and all new drawings and details therefore, shall be provided by the Contractor at his own cost and expense, and shall be subject to the approval of the Owner and Engineer.

C. In the event that the Engineer is required to provide additional engineering services, then the Engineer's charges for such additional services shall be charged to the Contractor by the Owner in accordance with the requirements of the General Conditions, and the Supplemental Conditions.

D. In all cases the Owner and Engineer shall be the judge as to whether a proposed substitution is to be approved. The Contractor shall abide by their decision when proposed substitute items are judged to be unacceptable and shall in such instances furnish the item specified or indicated. No substitute items shall be used in the work without written approval of the Owner and Engineer.

E. Contractor shall have and make no claim for an extension of time or for damages by reason of the time taken by the Engineer in considering a substitution proposed by the Contractor or by reason of the failure of the Engineer to approve a substitution proposed by the Contractor.

F. Acceptance of any proposed substitution shall in no way release the Contractor from any of the provisions of the Contract Documents.

PART 2 -- PRODUCTS

(NOT USED)

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 02050

DEMOLITION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, materials and equipment in accordance with the requirements of Section 01520 - Maintenance of Utility Operations During Construction.

B. In addition, the Contractor shall demolish and remove all concrete and asphaltic paving, curbs, sidewalk, and miscellaneous yard structures as required and shown on the Contract Drawings during the construction work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01090 - Reference Standards

B. Section 01520 - Maintenance of Utility Operations During Construction

C. Section 01540 - Demolition and Removal of Existing Structures and Equipment

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References shall be in accordance with reference standards, codes, and specifications as set forth herein and in Section 02100 - Clearing, Grubbing, and Site Preparation.

PART 2 -- EXECUTION

2.01 DEMOLITION

A. Existing concrete and asphaltic paving, curbs, sidewalk and miscellaneous yard structures within the areas designated for new construction work shall be completely demolished and all debris removed from the site.

B. Excavation caused by demolition shall be backfilled with fill free from rubbish and debris.

C. Work shall be performed in such manner as not to endanger the safety of the workmen or the public or cause damage to nearby structures.

D. Provide all barriers and precautionary measures in accordance with Owner's requirements and other authorities having jurisdiction.

E. Where parts of existing structures are to remain in service, demolish the portions to be removed, repair damage, and leave the structure in proper condition for the intended use. Remove concrete and masonry to the lines designated by drilling, chipping, or other suitable methods. Leave the resulting surfaces reasonably true and even, with sharp straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended. Where existing reinforcing rods are to extend into new construction, remove the

concrete so that the reinforcing is clean and undamaged. Cut off other reinforcing 1/2-inch below the surface and fill with epoxy resin binder flush with the surface.

F. Prior to the execution of the work, the Contractor, Owner and Engineer shall jointly survey the condition of the adjoining and/or nearby structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

2.02 DISPOSAL OF MATERIAL

A. All debris resulting from the demolition and removal work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed. All other material shall be disposed of off site by the Contractor at his expense.

B. Burning of any debris resulting from the demolition will not be permitted at the site.

- END OF SECTION -

SECTION 02100

CLEARING, GRUBBING, AND SITE PREPARATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Includes all labor, material, equipment and appliances required for the complete execution of any additions, modifications, or alterations to existing building(s) and new construction work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Notifying all authorities owning utility lines running to or on the property. Contractor shall call 811 (Kentucky Before You Dig) prior to beginning any construction activities on site. Protecting and maintaining all utility lines to remain and capping those that are not required in accordance with instructions of the Utility Companies, and all other authorities having jurisdiction.

2. Clearing the site within the Contract Limit Lines, including removal of grass, brush, shrubs, trees, loose debris and other encumbrances except for trees marked to remain.

4. Boxing and protecting all trees, shrubs, lawns and the like within areas to be preserved.

5. Immediately repairing all injury to trees, shrubs, and other plants caused by site preparation operations. Work shall be done by qualified personnel in accordance with standard horticultural practice.

6. Removing topsoil to its full depth from designated areas and stockpiling on site where directed for future use.

7. Disposing from the site all debris resulting from work under this Section in properly permitted disposal facilities.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

1.05 PROTECTION OF PERSONS AND PROPERTY

A. All work shall be performed in such a manner to protect all personnel, workmen, pedestrians and adjacent property and structures from possible injury and damage.

B. All drainage tiles, conduits, wires, cables and appurtenances above or below ground shall be protected from damage.

C. Provide warning and barrier fence where shown on the Drawings and as specified herein.

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PART 2 -- EXECUTION

2.01 CLEARING OF SITE

A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.

B. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Prior to the start of construction, the Contractor shall survey the entire Contract site and shall prepare a plan which defines the areas to be cleared and grubbed, trees to be pruned, extent of tree pruning, and/or areas which are to be cleared but not grubbed. This plan shall be submitted to the Engineer for approval. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.

C. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02200 - Earthwork.

D. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15 ft. wide along all permanent fence lines installed under this Contract.

E. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

2.02 STRIPPING AND STOCKPILING EXISTING TOPSOIL

A. Existing topsoil and sod on the site within areas designated on the Drawings shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

B. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil.

C. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

2.03 GRUBBING

A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.

B. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

2.04 DISPOSAL OF MATERIAL

A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.

B. Burning of any debris resulting from the clearing and grubbing work will not be permitted at the site.

2.05 WARNING AND BARRIER FENCE

A. The fence shall be made of a high visiblity, durable, U.V. stabilized high density polyethylene (HDPE) material. The fence shall be MIRASAFE as manufactured by Mirafi, Inc., or equal.

B. Physical Properties

Fence:

| | |
|---|---|
| Color: | International Orange |
| Roll Size: | 4' x 164' |
| Roll weight: | 34 lbs. |
| Mesh opening: | 1-1/2" x 3" |

Posts:

| | |
|---|---|
| ASTM Designation: | ASTM 702 |
| Length: | 5 feet long (T-Type) |
| Weight: | 1.25 #/Foot (min) |
| Area of Anchor Plate: | 14 Sq. In. |

C. Drive posts 12 to 18 inches into ground every 10' to 12'. Wrap fence material around first terminal post allowing overlap of one material opening. Use metal tie wire or plastic tie wrap to fasten material to itself at top, middle and bottom. At final post, cut with utility knife or scissors at a point halfway across an opening. Wrap around and tie at final post in the same way as the first post.

D. Use tie wire or tie wrap at intermediate posts and splices as well. Thread ties around a vertical member of the fence material and the post, and bind tightly against the post. For the most secure fastening, tie at top, middle and bottom. Overlap splices a minimum of four fence openings, tie as above, fastening both edges of the fence material splice overlap.

- END OF SECTION -

SECTION 02200

EARTHWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment and materials required to complete all work associated with excavation, including off-site borrow excavation, dewatering, backfill, drainage layers beneath and around structures, foundation and backfill stone, filter fabric, embankments, stockpiling topsoil and any excess suitable material in designated areas, in place compaction of embankments, backfill and subgrades beneath foundations and roadways, excavation support, disposing from the site all unsuitable materials, providing erosion and sedimentation control grading, site grading and preparation of pavement and structure subgrade, and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

B. All excavations shall be in conformity with the lines, grades, and cross sections shown on the Drawings or established by the Engineer.

C. It is the intent of this Specification that the Contractor conduct the construction activities in such a manner that erosion of disturbed areas and off-site sedimentation be absolutely minimized.

D. All work under this Contract shall be done in conformance with and subject to the limitations of the latest editions of the Kentucky Department of Highways (KYTC) Standards and Specifications and the Lexington Fayette Urban County Government Stormwater Manual.

E. Contractor shall also provide quality control testing of all earthwork construction as required by the Engineer to confirm conformance with Specifications. Testing shall be conducted by a geotechnical consultant specializing in earthwork investigation and quality control testing. Qualifications of proposed consultant shall be submitted to the Engineer for approval.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. KYTC Standards and Specifications, latest edition.

2. American Society for Testing and Materials (ASTM):

ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.

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| ASTM C 136 | Test for Sieve Analysis of Fine and Coarse Aggregates. |
| ASTM D 422 | Particle Size Analysis of Soils. |
| ASTM D 423 | Test for Liquid Limit of Soils. |
| ASTM D 424 | Test for Plastic Limit and Plasticity Index of Soils. |
| ASTM C 535 | Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. |
| ASTM D 698 | Standard Method of Test for the Moisture - Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12-inch (305 mm) Drop. |
| ASTM D1556 | Test for Density of Soil in Place by the Sand-Cone Method. |
| ASTM D1557 | Test for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lbs. (4.5 kg) Rammer and 18-inch (457 mm) Drop. |
| ASTM D2049 | Test Method for Relative Density of Cohesionless Soils. |
| ASTM D2167 | Test for Density of Soil in Place by the Rubber-Balloon Method. |
| ASTM D2216 | Test for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures. |
| ASTM D2487 | Test for Classification of Soils for Engineering Purposes. |
| ASTM D2922 | Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). |

1.04 SUBSURFACE CONDITIONS

A. Information on subsurface conditions is referenced under Division 1, General Requirements.

B. Attention is directed to the fact that there may be water pipes, storm drains and other utilities located in the area of proposed excavation. Perform all repairs to same in the event that excavation activities disrupt service.

C. A copy of the geotechnical report is available upon request.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, the Contractor shall submit the following:

1. Name and location of all material suppliers.

2. Certificate of compliance with the standards specified above for each source of each material.

3. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

4. Plans and cross sections of open cut excavations showing side slopes and limits of the excavation at grade.

5. Samples of synthetic filter fabric and reinforced plastic membrane with manufacturer's certificates or catalog cuts stating the mechanical and physical properties. Samples shall be at least one (1) foot wide and four (4) feet long taken across the roll with the warp direction appropriately marked.

6. Construction drawings and structural calculations for any types of excavation support required. Drawings and calculations shall be sealed by a currently registered Professional Engineer.

7. Monitoring plan and pre-construction condition inspection and documentation of all adjacent structures, utilities, and roadways near proposed installation of excavation support systems.

8. Dewatering procedures.

9. Name of company proposed to do quality control testing for earthwork operations and qualifications of proposed company.

1.06 PRODUCT HANDLING

A. Soil and rock material shall be excavated, transported, placed, and stored in a manner so as to prevent contamination, segregation and excessive wetting. Materials which have become contaminated or segregated will not be permitted in the performance of the work and shall be removed from the site.

PART 2 -- PRODUCTS

2.01 SELECT FILL

A. Soils from the excavations meeting requirements stipulated herein with the exceptions of topsoil and organic material may be used as select fill for backfilling, constructing embankments, reconstructing existing embankments, and as structural subgrade support.

B. Select fill used for embankment construction shall be a silty or clayey soil material with a Maximum Liquid Limit (LL) of 50 and a Plasticity Index (PI) between 10 and 20.

C. Select fill used for backfilling shall either be material as described in Paragraph B above or a granular soil material with a Maximum Plasticity Index (PI) of 9.

D. Regardless of material used as select fill, materials shall be compacted at a moisture content satisfactory to the Engineer, which shall be approximately that required to produce the maximum density except that the moisture content shall not be more than 2% below nor more than 4 above the optimum moisture content for the particular material tested in accordance with the ASTM D698.

E. Select fill used as subgrade support shall be a coarse aggregate material meeting the gradation requirements as defined in Section 02207 – Aggregate Materials.

F. Where excavated material does not meet requirements for select fill, Contractor shall furnish off-site borrow material meeting the specified requirements herein.

2.02 TOPSOIL

A. Topsoil shall be considered the surface layer of soil and sod, suitable for use in seeding and planting. It shall contain no mixture of refuse or any material toxic to plant growth.

2.03 GEOTEXTILES

A. The Contractor shall provide geotextiles as indicated on the Drawings and specified herein. The materials and placement shall be as indicated under Section 02274 - Geotextiles.

PART 3 -- EXECUTION

3.01 STRIPPING OF TOPSOIL

A. In all areas to be excavated, filled, paved, or graveled the topsoil shall be stripped to its full depth and shall be deposited in storage piles on the site, at locations designated by the Engineer, for subsequent reuse. Topsoil shall be kept separated from other excavated materials and shall be piled free of roots and other undesirable materials.

3.02 EXCAVATION

A. All material excavated, regardless of its nature or composition, shall be classified as UNCLASSIFIED EXCAVATION. Excavation shall include the removal of all soil, rock, weathered rock, rocks of all types, boulders, conduits, pipe, and all other obstacles encountered and shown to be removed within the limits of excavation shown on the Drawings or specified herein.

B. All suitable material removed in the excavation shall be used as far as practicable in the formation of embankments, subgrades, and shoulders, and at such other places as may be indicated on the Drawings or indicated by the Engineer. No excavation shall be wasted except as may be permitted by the Engineer. Refer to the Drawings for specific location and placement of suitable excavated materials in the formation of embankments, backfill, and structural and roadway foundations. THE ENGINEER OR OWNERS REPRESENTATIVE WILL DESIGNATE MATERIALS THAT ARE UNSUITABLE. The Contractor shall furnish off-site disposal areas for the unsuitable material. Where suitable materials containing excessive moisture are encountered above grade in cuts, the Contractor shall construct above grade ditch drains prior to the excavation of the cut material when in the opinion of the Engineer such measures are necessary to provide proper construction.

C. All excavations shall be made in the dry and in such a manner and to such widths as will give ample room for properly constructing and inspecting the structures and/or piping they are to contain and for such excavation support, pumping and drainage as may be required. Excavation shall be made in accordance with the grades and details shown on the Drawings and as specified herein.

D. Excavation slopes shall be flat enough to avoid slides that will cause disturbance of the subgrade or damage of adjacent areas. Excavation requirements and slopes shall be as indicated in the Drawings. The Contractor shall intercept and collect surface runoff both at the top and bottom of cut slopes. The intersection of slopes with natural ground surfaces, including the beginning and ending of cut slopes, shall be uniformly rounded as shown on the Drawings or as may be indicated by the Engineer. Concurrent with the excavation of cuts the Contractor shall construct intercepting berm ditches or earth berms along and on top of the cut slopes at locations shown on the Drawings or designated by the Engineer. All slopes shall be finished to reasonably uniform surfaces acceptable for seeding and mulching operations. No rock or boulders shall be left in place which protrude more than 1 foot within the typical section cut slope lines, and all rock cuts shall be cleaned of loose and overhanging material. All protruding roots and other objectionable vegetation shall be removed from slopes. The Contractor shall be required to submit plans of open-cut excavation for review by the Contractor before approval is given to proceed.

E. It is the intent of these Specifications that all structures shall bear on an aggregate base, crushed stone or screened gravel bedding placed to the thickness shown on the Drawings, specified in these Specifications, or not less than 6-inches. Bedding for process piping shall be as specified in Section 15000 - Basic Mechanical Requirements, or as shown on the Drawings.

F. The bottom of all excavations for structures and pipes shall be examined by the Contractor for bearing value and the presence of unsuitable material. If, in the opinion of the Engineer, additional excavation is required due to the low bearing value of the subgrade material, or if the in-place soils are soft, yielding, pumping and wet, the Contractor shall remove such material to the required width and depth and replace it with thoroughly compacted select fill, and/or crushed stone or screened gravel as indicated by the Engineer. Payment for such additional work ordered by the Contractor shall be made as an extra by a Change Order in accordance with the General Conditions and Division 1. No payment will be made for subgrade disturbance caused by inadequate dewatering or improper construction methods.

G. All cuts shall be brought to the grade and cross section shown on the Drawings, or established by the Engineer, prior to final inspection and acceptance by the Engineer.

H. Slides and overbreaks which occur due to negligence, carelessness or improper construction techniques on the part of the Contractor shall be removed and disposed of by the Contractor as indicated by the Contractor at no additional cost to the Owner. If grading operations are suspended for any reason whatsoever, partially completed cut and fill slopes shall be brought to the required slope and the work of seeding and mulching or other required erosion and sedimentation control operations shall be performed.

I. Where the excavation exposes sludge, sludge contaminated soil or other odorous materials, the Contractor shall cover such material at the end of each workday with a minimum of 6-inches and a maximum of 24-inches of clean fill. The work shall be an odor abatement measure and the material shall be placed to the depth deemed satisfactory by the Contractor for this purpose.

3.03 EXCAVATION SUPPORT

A. The Contractor shall furnish, place, and maintain such excavation support which may be required to support sides of excavation or to protect pipes and structures from possible damage and to provide safe working conditions. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at the expense of the Contractor. The Contractor shall be responsible for the adequacy of all supports used and for all damage resulting from failure of support system or from placing, maintaining and removing it.

B. Selection of and design of any proposed excavation support systems is exclusively the responsibility of the Contractor. Contractor shall submit drawings and calculations on proposed systems sealed by a Professional Engineer.

C. The Contractor shall exercise caution in the installation and removal of supports to insure that excessive or unusual loadings are not transmitted to any new or existing structure. The Contractor shall promptly repair at his expense any and all damage that can be reasonably attributed to installation or removal of excavation support system.

D. Contractor shall monitor movement in the excavation support systems as well as movement at adjacent structures, utilities and roadways near excavation supports. Contractor shall submit a monitoring plan developed by the excavation support design engineer. All pre-construction condition assessment and documentation of adjacent structures on-site and off-site shall be performed by the Contractor. If any sign of distress such as cracking or movement occurs in any adjacent structure, utility or roadway during installation of supports, subsequent excavation, service period of supports, subsequent backfill and construction, or removal of supports, Contractor shall be notified immediately. Contractor shall be exclusively responsible for any damage to any roadway, structure, utility, pipes, etc. both on-site and off-site, as a result of his operations.

E. All excavation supports shall be removed upon completion of the work except as indicated herein. The Engineer may permit supports to be left in place at the request and expense of the Contractor. The Engineer may order certain supports left permanently in place in addition to that required by the Contract. The cost of the materials so ordered left in place, less a reasonable amount for the eliminated expense of the removal work omitted, will be paid as an extra by a Change Order in accordance with the General Conditions and Division 1. Any excavation supports left in place shall be cut off at least two (2) feet below the finished ground surface or as directed by the Engineer.

3.04 PROTECTION OF SUBGRADE

A. To minimize the disturbance of bearing materials and provide a firm foundation, the Contractor shall comply with the following requirements:

1. Use of heavy rubber-tired construction equipment shall not be permitted on the final subgrade unless it can be demonstrated that drawdown of groundwater throughout the entire area of the structure is at least 3 feet below the bottom of the excavation (subgrade). Even then, the use of such equipment shall be prohibited should subgrade disturbance result from concentrated wheel loads.

2. Subgrade soils disturbed through the operations of the Contractor shall be excavated and replaced with compacted select fill or crushed stone at the Contractor's expense as indicated by the Engineer.

3. The Contractor shall provide positive protection against penetration of frost into materials below the bearing level during work in winter months. This protection can consist of a temporary blanket of straw or salt hay covered with a plastic membrane or other acceptable means.

3.05 PROOFROLLING

A. The subgrade of all structures and all areas that will support pavements or select fill shall be proofrolled. After stripping of topsoil, excavation to subgrade and prior to placement of fills, the exposed subgrade shall be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft, or loose soil, and other undesirable materials shall be removed. The exposed subgrade shall be proofrolled with a heavily loaded tandem-wheeled dump truck to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed shall be removed and replaced with an approved compacted material.

3.06 DEWATERING

A. The Contractor shall do all dewatering as required for the completion of the work. Procedures for dewatering proposed by the Contractor shall be submitted to the Contractor for review prior to any earthwork operations. All water removed by dewatering operations shall be disposed of in accordance with the local sedimentation and erosion control regulations.

B. The dewatering system shall be of sufficient size and capacity as required to control groundwater or seepage to permit proper excavation operations, embankment construction and reconstruction, subgrade preparation, and to allow concrete to be placed in a dry condition. The system shall include a sump system or other equipment, appurtenances and other related earthwork necessary for the required control of water. The Contractor shall drawdown groundwater to at least 3 feet below the bottom of excavations (subgrade) at all times in order to maintain a dry and undisturbed condition.

C. The Contractor shall control, by acceptable means, all water regardless of source. Water shall be controlled and its disposal provided for at each berm, structure, etc. when necessary. The entire periphery of the excavation areas shall be ditched and diked to prevent water from entering the excavation where applicable. The Contractor shall be fully responsible for disposal of the water and shall provide all necessary means at no additional expense to the Owner. The Contractor shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.

D. The Contractor shall be responsible for and shall repair without cost to the Owner, any damage to work in place and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area. The Contractor shall be responsible for damages to any other area or structure caused by his failure to maintain and operate the dewatering system proposed and installed by the Contractor.

E. The Contractor shall take all the steps that he considers necessary to familiarize himself with the surface and subsurface site conditions, and shall obtain the data that is required to analyze the water and soil environment at the site and to assure that the materials used for the dewatering systems will not erode, deteriorate, or clog to the extent that the dewatering systems will not perform properly during the period of dewatering. Copies of logs of borings and laboratory test results are available to the Contractor. This data is furnished for

information only, and it is expressly understood that the Owner and Engineer will not be held responsible for any interpretations or conclusions drawn therefrom by the Contractor.

F. Prior to the execution of the work, the Engineer, Owner and Contractor shall jointly survey the condition of adjoining structures. Photographs and records shall be made of any prior settlement or cracking of structures, pavements, and the like, that may become the subject of possible damage claims.

3.07 EMBANKMENTS

A. The Contractor shall perform the construction of embankments in such a manner that cut and fill slopes will be completed to final slopes and grade in a continuous operation. The operation of removing excavation material from any cut and the placement of embankment in any fill shall be a continuous operation to completion unless otherwise permitted by the Engineer.

B. Surfaces upon which embankments are to be constructed shall be stripped of topsoil, organic material, rubbish and other extraneous materials. After stripping and prior to placing embankment material, the Contractor shall compact the top 12-inches of in place soil as specified under Paragraph 3.09, COMPACTION.

C. Any soft or unsuitable materials revealed before or during the in place compaction shall be removed as indicated by the Engineer and replaced with select fill.

D. Ground surfaces, on which embankment is to be placed, shall be scarified or stepped in a manner which will permit bonding of the embankment with the existing surface. The embankment soils shall be as specified under Part 2 - Products, and shall be deposited and spread in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width of the cross section, and shall be kept approximately level by the use of effective spreading equipment. Hauling shall be distributed over the full width of the embankment, and in no case will deep ruts be allowed to form during the construction of the embankment. The embankment shall be properly drained at all times. Each layer of the embankment shall be thoroughly compacted to the density specified under Paragraph 3.09, COMPACTION.

E. The embankment or fill material in the layers shall be of the proper moisture content before rolling to obtain the prescribed compaction. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work on all portions of the embankment thus affected shall be delayed until the material has dried to the required moisture content. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken at frequent intervals. From these tests, corrections, adjustments, and modifications of methods, materials, and moisture content will be made to construct the embankment.

F. Where embankments are to be placed and compacted on hillsides, or when new embankment is to be compacted against embankments, or when embankment is built in part widths, the slopes that are steeper than 4:1 shall be loosened or plowed to a minimum depth of 6 inches or, if in the opinion of the Engineer, the nature of the ground is such that greater precautions should be taken to bind the fill to the original ground then benches shall be cut in the existing ground as indicated by the Engineer.

G. When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portions of the embankments and the other material which meets the requirements for select fill shall be incorporated into the formation of the embankments. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the final grade. Stones, fragmentary rock, or boulders larger than 12-inches in their greatest dimension will not be allowed in any portions of embankments and shall be disposed of by the Contractor as indicated by the Engineer. When rock fragments or stone are used in embankments, the material shall be brought up in layers as specified or directed and every effort shall be exerted to fill the voids with finer material to form a dense, compact mass which meets the densities specified for embankment compaction.

3.08 BACKFILLING

A. All structures and pipes shall be backfilled with the type of materials shown on the Drawings and specified herein. Select fill shall be deposited in successive, uniform, approximately horizontal layers not exceeding 8-inches in compacted depth for the full width. Stones or fragmentary rock larger than 4-inches in their greatest dimension will not be allowed within the top 6-inches of the ground nor within 6 inches of pipes. No stone or fragmentary rock larger than 12-inches in their greatest dimension will be allowed for any portion of backfill. Compaction shall be in accordance with the requirements of Paragraph 3.09, COMPACTION.

B. Where excavation support is used, the Contractor shall take all reasonable measures to prevent loss of support beneath and adjacent to pipes and existing structures when supports are removed. If significant volumes of soil cannot be prevented from clinging to the extracted supports, the voids shall be continuously backfilled as rapidly as possible. The Contractor shall thereafter limit the depth below subgrade that supports will be installed in similar soil conditions or employ other appropriate means to prevent loss of support.

3.09 COMPACTION

A. The Contractor shall compact embankments, backfill, crushed stone, aggregate base, and in place subgrade in accordance with the requirements of this Section. The densities specified herein refer to percentages of maximum density as determined by the noted test methods. Compaction of materials on the project shall be in accordance with the following schedule:

| | Density % Std. Proctor (D698) | Density % Mod. Proctor (D1557) | Max. Lift Thickness as Compacted Inches |
|---|---|---|---|
| Embankments Beneath Structures* | 98 | 95 | 8 |
| Other Embankments | 95 | 92 | 8 |
| Backfill Around Structures | 95 | 92 | 8 |
| Backfill in Pipe Trenches | 95 | 92 | 8 |
| Crushed Stone Beneath Structures | ** | ** | 12 |
| Select Sand | -- | 98 | 8 |
| Aggregate Base Course (ABC) Beneath Pavements and Structures | -- | 98 | 8 |
| Crushed Stone Backfill | ** | ** | 12 |

| | Density % Std. Proctor (D698) | Density % Mod. Proctor (D1557) | Max. Lift Thickness as Compacted Inches |
|---|---|---|---|
| Crushed Stone Pipe Bedding | ** | ** | 12 |
| In place Subgrade Beneath Structures | 98 | 95 | Top 12-inches |

* Embankments beneath structures shall be considered to include a zone 10 feet out from the foundation of the structure extending down to the natural ground on a 45° slope.

** The aggregate shall be compacted to a degree acceptable to the Engineer by use of a vibratory compactor and/or crawler tractor.

B. Field density tests will be made by the Contractor to determine if the specified densities have been achieved, and these tests shall be the basis for accepting or rejecting the compaction. In-place density tests will be performed in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 2922. The Engineer will be the sole judge as to which test method will be the most appropriate. Failure to achieve the specified densities shall require the Contractor to re-compact the material or remove it as required. The Contractor shall, if necessary, increase his compactive effort by increasing the number of passes, using heavier or more suitable compaction equipment, or by reducing the thickness of the layers. The Contractor shall adjust the moisture contents of the soils to bring them within the optimum range by drying them or adding water as required.

C. Testing will be performed as frequently as deemed necessary by the Engineer. As a minimum, one in-place density test shall be performed for each 1000 cubic yards of embankment placed and 500 cubic yards of backfill placed or one test performed each day for either. The cost of all laboratory tests on grout will be borne by the Contractor.

3.10 REMOVAL OF EXCESS AND UNSUITABLE MATERIALS

A. The Contractor shall remove and dispose of off-site all unsuitable materials. Within thirty (30) consecutive days after Notice to Proceed, the Contractor shall submit to the Engineer for review all required permits and a list of disposal sites for the unsuitable materials. If the disposal site is located on private property, the submittal shall also include written permission from the owner of record.

B. All unsuitable materials shall be disposed of in locations and under conditions that comply with federal, state and local laws and regulations.

C. The Contractor shall obtain an off-site disposal area prior to beginning demolition or excavation operations.

D. Any surplus excavated material not used for backfilling or embankment suitable for reuse shall be deposited on-site in the disposal area indicated on the Drawings, hauled in trucks of sufficient capacity and tight construction to prevent spillage, or disposed of as directed by the Engineer. Trucks used for hauling of excess and unsuitable materials shall be covered to prevent the propagation of dust. Approved disposal areas may also be used by the Contractor for spreading and drying any excavated material suitable as select fill that is too wet for use immediately after being excavated. The Contractor shall maintain the earth surfaces of the disposal area, both during the work and until the completion of all seeding and mulching or other erosion control measures specified, in a manner which will effectively

control erosion and sedimentation. If necessary, the Contractor shall clear and grub the disposal site prior to any excavation work.

1. Earth waste shall be shaped to contours which are comparable to and blend in with the adjacent topography where practical, but in no case will slopes steeper than 3 horizontal to 1 vertical be permitted.

2. Seeding and mulching shall be performed over all the earth waste area. The work of seeding and mulching shall be performed in accordance with Section 02910 - Final Grading and Landscaping.

3. The Contractor shall have the authority to establish whatever additional requirements may be necessary to insure the satisfactory appearance of the completed work.

E. When all excess and unsuitable material disposal operations are completed, the Contractor shall leave the disposal sites in a condition acceptable to the Owner and Owner(s) of the disposal site(s).

3.11 BORROW EXCAVATION

A. Description

The work covered by this section consists of the excavation of approved material from borrow sources and the hauling and utilization of such material as required on the Drawings or directed by the Engineer. It shall also include the removing, stockpiling, and replacement of topsoil on the borrow source; the satisfactory disposition of material from the borrow source which is not suitable for use; and the satisfactory restoration of the borrow source and haul roads to an acceptable condition upon completion of the work.

Borrow excavation shall not be used before all available suitable unclassified excavation has been used for backfill and incorporated into the embankments.

B. Coordination with Seeding Operations

The Contractor shall coordinate the work covered by this section with the construction of embankments so that the requirements of Section 02200 – Earthwork are met.

C. Materials

All material shall meet the requirements of Division 2 shown below:

Borrow Material.....Section 02200, Subsection 2.01 - Select Fill

D. Construction Methods

1. General

The surface of the borrow area shall be thoroughly cleared and grubbed and cleaned of all unsuitable material including all organics, topsoil, etc., before beginning the excavation. Disposal of material resulting from clearing and grubbing shall be in accordance with Section 02100 – Clearing, Grubbing, and Site Preparation.

Each borrow operation shall not be allowed to accumulate exposed, erodible slope area in excess of 1 acre at any one given time without the Contractor's beginning permanent seeding and mulching of the borrow source or other erosion control measures as may be approved by the Engineer.

The topsoil shall be removed and stockpiled at locations that will not interfere with the borrow operations and that meet the approval of the Engineer. Temporary erosion control measures shall be installed as may be necessary to prevent the erosion of the stockpile material. Once all borrow has been removed from the source or portion thereof, the stockpiled topsoil shall be spread uniformly over the source.

Where it is necessary to haul borrow material over existing roads, the Contractor shall use all necessary precautions to prevent damage to the existing roads. The Contractor shall also conduct his hauling operations in such a manner as to not interfere with the normal flow of traffic and shall keep the traffic lanes free from spillage at all times.

2. Owner Furnished Sources

Where borrow sources are furnished by the Owner the location of such sources will be as designated on the Drawings or as directed by the Engineer.

The borrow sources shall be left in a neat and presentable condition after use. All slopes shall be smoothed, rounded, and constructed not steeper than 3:1. Where the source is to be reclaimed for cultivation the source shall be plowed or scarified to a minimum depth of 8 inches, disc harrowed, and terraces constructed. The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided.

All sources shall be seeded and mulched in accordance with Section 02910 – Final Grading and Landscaping.

3. Contractor Furnished Sources

Prior to the approval of any off-site borrow source(s) developed for use on this project, the Contractor shall obtain certification from the State Historic Preservation Officer of the State Department of Cultural Resources certifying that the removal of the borrow material from the borrow source(s) will have no effect on any known district, site building, structure, or object that is included or eligible for inclusion in the National Register of Historic Places. A copy of this certification shall be furnished to the Contractor prior to performing any work on the proposed borrow source.

The approval of borrow sources furnished by the Contractor shall be subject to the

following conditions:

a. The Contractor shall be responsible for acquiring the right to take the material and any rights of access that may be necessary; for locating and developing the source; and any clearing and grubbing and drainage ditches necessary.

Such right shall be in writing and shall include an agreement with the Owner that the borrow source may be dressed, shaped, seeded, mulched, and drained as required by these Specifications after all borrow has been removed.

b. Except where borrow is to be obtained from a commercial source, the Contractor and the property owner shall jointly submit a borrow source development, use, and reclamation plan to the Contractor for his approval prior to engaging in any land disturbing activity on the proposed source other than material sampling that may be necessary. The Contractor's plan shall address the following:

(1) Drainage

The source shall be graded to drain such that no water will collect or stand and a functioning drainage system shall be provided. If drainage is not practical, and the source is to serve as a pond, the minimum average depth below the water table shall be 4 feet or the source graded so as to create wetlands as appropriate.

(2) Slopes

The source shall be dressed and shaped in a continuous manner to contours which are comparable to and blend in with the adjacent topography, but in no case will slopes steeper than 3:1 be permitted.

(3) Erosion Control

The plan shall address the temporary and permanent measures that the Contractor intends to employ during use of the source and as a part of the reclamation. The Contractor's plan shall provide for the use of staged permanent seeding and mulching on a continual basis while the source is in use and the immediate total reclamation of the source when no longer needed.

4. Maintenance

During construction and until final acceptance the Contractor shall use any methods approved by the Contractor which are necessary to maintain the work covered by this section so that the work will not contribute to excessive soil erosion.

- END OF SECTION -

SECTION 02207

AGGREGATE MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all labor, equipment and materials required to complete all work associated with the installation of aggregate material beneath foundations, as backfill and as roadway subgrades and other related and incidental work as required to complete the work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01090 - Reference Standards

B. Section 02200 - Earthwork

C. Section 02276 - Erosion and Sedimentation Control

D. Section 02510 - Paving and Surfacing

E. Section 02712 - Foundation Drainage Systems

F. Section 02910 - Final Grading and Landscaping

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Kentucky Department of Highways (KYTC) Standard Specifications for Roads and Bridge Construction.

2. ASTM C 127 Test for Specific Gravity and Absorption of Coarse Aggregate.

3. ASTM C 136 Test for Sieve Analysis of Fine and Coarse Aggregates.

4. ASTM C 535 Test for Resistance to Degradation of Large Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Materials gradation and certification.

2. ASTM C127, ASTM C136, and ASTM C535 test results

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PART 2 -- PRODUCTS

2.01 CRUSHED STONE, SCREENED GRAVEL and AGGREGATE BASE COURSE (ABC)

A. Crushed stone or screened gravel shall meet the requirements of Aggregate Standard Size No. 57 or No. 67 as defined by KYTC Standard Specifications.

B. ABC shall meet the requirements of ABC as defined by KYTC Standard Specifications.

2.02 SELECT SAND

A. Select sand shall meet the requirements of Sections 1005 and 1014 of the KYTC Standard Specifications for materials and gradation. The size used shall be Standard Size No. 2S or 2MS as listed and defined in Table 1005-2, "Aggregate Gradation", of the KYTC Standard Specifications.

PART 3 -- EXECUTION

3.01 CRUSHED STONE, SCREENED GRAVEL AND AGGREGATE BASE COURSE (ABC)

A. Contractor shall install crushed stone, screened gravel and ABC in accordance with the KYTC Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.

1. Unless otherwise stated herein or shown on the Drawings, all mat foundations (bottom slabs) for the proposed structures shall have a blanket of crushed stone or ABC 6-inches thick minimum placed directly beneath the proposed mat. The blanket shall extend a minimum of 12 inches beyond the extremities of the mat.

2. For subgrade preparation at structures and structural fill, the foundation material shall be ABC where specifically specified on Drawings, otherwise, crushed stone or screened gravel shall be used.

3. For ground under drains, pipe bedding, and drainage layers beneath structures the coarse aggregate shall meet the requirements of aggregate standard Size No. 57 or No. 67, as defined by KYTC Standard Specifications.

3.02 SELECT SAND

A. Contractor shall install select sand in accordance with the KYTC Standard Specifications and as shown on the Drawings and indicated in the Contract Documents.

- END OF SECTION -

SECTION 02225

EXCAVATING, BACKFILLING, AND COMPACTING FOR SEWERS

PART 1 - GENERAL

1.01 SUMMARY

A. Excavating of trenches.

B. Bedding of pipe.

C. Backfilling trenches.

PART 2 - PRODUCTS

2.01 BEDDING AND BACKFILLING STONE

A. Crushed Stone material shall conform to the Kentucky Transportation Cabinet's Standard Specifications for Road and Bridge Construction, Current Edition, latest revision.

B. Bedding Stone: No. 9 Crushed Limestone

C. Backfill Stone: No. 9 Crushed Limestone

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. Trenching may be accomplished by means of a backhoe, trenching machine, hydro-excavation or by hand depending on the construction area. At the Contractor's option, trenching by a trenching machine or by backhoe is acceptable.

B. Clearing - All trees, stumps, bushes, shrubbery, and abandoned concrete or masonry structures within the limits of the trench shall be removed by the Contractor and disposed of in a manner in accordance with federal, state and local regulations. All clearing work shall be considered as incidental to the cost of laying pipe.

C. Bracing and Sheeting - Bracing and sheeting shall be provided to adequately protect the workers during pipe line installation.

1. All requirements of the Occupational Safety and Health Act (OSHA) shall be met during trenching and backfill operations.

2. As backfill is placed, the sheeting shall be withdrawn in increments not exceeding one (1) foot and the void left by the withdrawn sheeting shall be filled and with #9 stone.

3. The Engineer will not be responsible for determining requirements for bracing or sheeting.

3.02 TRENCHING

A. General:

1. The Contractor shall perform all excavation of every description and of whatever substances encountered, including clearing over the pipeline route. All excavations for the pipeline shall be open-cut except where noted for bore and jack.

B. Trench Width:

1. Trench widths shall be in accordance with the Drawings, and at least 12 inches wider than the pipe being installed.

2. Contractor shall submit a shop drawing that includes a certification from the pipe manufacturer stating the recommended trench width for each pipe size and material being used.

C. Trench Depth:

1. The trench shall be excavated to a minimum of six (6) inches below pipe grade.

D. Blasting for excavation will not be permitted unless approved by the Engineer and Owner.

3.03 GRAVITY SEWER PIPE BEDDING

A. Refer to Lexington Fayette Urban County Government (LFUCG) Standard Drawings.

3.06 GRAVITY SEWER PIPE BACKFILLING

A. Refer to LFUCG Standard Drawings.

END OF SECTION

SECTION 02274

GEOTEXTILES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all Geotextiles, including all necessary and incidental items, as detailed or required for the Contractor to complete the installation in accordance with the Drawings and these Specifications.

B. For the location of each type of Geotextile see the Drawings.

1.02 REFERENCES

A. AASHTO Standards

1. AASHTO M 288-06 (2011) Geotextile Specification for Highway Applications

1.03 SUBMITTALS

A. Prior to shipping to the site, the Contractor shall submit to the Engineer two copies of a mill certificate or affidavit signed by a legally authorized official of the Manufacturer for each type of Geotextile. The Supplier shall also submit three Geotextile samples of each product, 1 yard square each, seamed and unseamed as appropriate, with the mill certificate for each Geotextile type supplied. The mill certificate or affidavit shall attest that the Geotextile meets the chemical, physical and manufacturing requirements stated in the specifications. The samples shall be labeled with the manufacturer's lot number, machine direction, date of sampling, project number, specifications, manufacturer and product name.

B. The Engineer shall be furnished copies of the delivery tickets or other acceptable receipts as evidence for materials received that will be incorporated into construction.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Filter Geotextile shall be a minimum 6-ounce per square yard (nominal) nonwoven needle punched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10. The Geotextiles shall have a minimum threshold water head of 0.25-inches in the "as received" condition.

1. Filter Geotextile shall have a Survivability Class of Class 1, 2 or 3 in accordance with AASHTO M288, unless otherwise specified herein.

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B. Cushion Geotextile shall be a minimum 16-ounce per square yard nonwoven needle punched synthetic fabric consisting of continuous filament or staple polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long-term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Cushion Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288.

C. Type I Separator Geotextile shall be a minimum 8-ounce per square yard (nominal) nonwoven neddlepunched synthetic fabric consisting of staple or continuous filament polyester or polypropylene manufactured in a manner accepted by the Engineer and the Owner. The Geotextiles shall be inert and unaffected by long term exposure to chemicals or liquids with a pH range from 3 to 10.

1. Type I Separator Geotextile shall have a Survivability Class of Class 1 or 2 in accordance with AASHTO M288, unless otherwise specified herein.

D. Type II Separator Geotextile shall be a woven slit film or monofilament synthetic fabric consisting of polyester or polypropylene in a manner approved by the Engineer. Geotextile shall be treated to resist degradation due to exposure to ultraviolet light.

1. Type II Separator Geotextile shall have a Survivability Class of Class 1 in accordance with AASHTO M288, unless otherwise specified herein.

E. All Geotextiles shall conform to the properties listed using the test methods listed in Table 1. The Contractor shall be responsible for timely submittals of all confirmation test data for Geotextiles.

## PART 3 -- EXECUTION

### 3.01 SHIPPING, HANDLING AND STORAGE

A. During all periods of shipment and storage, all Geotextiles shall be protected from direct sunlight, temperature greater than 140°F water, mud, dirt, dust, and debris.

B. To the extent possible, the Geotextile shall be maintained wrapped in heavy-duty protective covering until use. Geotextile delivered to the project site without protective covering shall be rejected. After the protective covering has been removed, the Geotextile shall not be left uncovered for longer than fourteen (14) days, under any circumstances.

C. The Owner shall approve the shipping and delivery schedule prior to shipment. The Owner shall designate the on-site storage area for the Geotextiles. Unloading and storage of Geotextiles shall be the responsibility of the Contractor.

D. Geotextiles that are damaged during shipping or storage shall be rejected and replaced at Contractor expense.

3.02 QUALITY ASSURANCE CONFORMANCE TESTING

A. At the option of the Engineer representative samples of Geotextiles shall be obtained and tested by the Engineer to assure that the material properties conform to these Specifications. Conformance testing shall be conducted by the Engineer and paid for by the Owner.

B. Conformance testing shall be completed at a minimum frequency of one sample per 100,000 square feet of Geotextile delivered to the project site. Sampling and testing shall be as directed by the Engineer.

C. Conformance testing of the Geotextiles shall include but not be limited to the following properties:

1. Mass Per Unit Area (ASTM D5261)
2. Grab Tensile Strength (ASTM D4632)
3. Trapezoidal Tear (ASTM D4533)
4. Puncture Resistance (ASTM D6241)

D. The Engineer may add to, remove or revise the test methods used for determination of conformance properties to allow for use of improved methods.

E. All Geotextile conformance test data shall meet or exceed requirements outlined in Table 1 of these Specifications for the particular category of Geotextile prior to installation. Any materials that do not conform to these requirements shall be retested or rejected at the direction of the Engineer.

F. Each roll of Geotextile will be visually inspected by the Engineer or his representative. The Engineer reserves the right to sample and test at any time and reject, if necessary, any material based on visual inspection or verification tests.

G. A Geotextile that is rejected shall be removed from the project site and replaced at the Contractor's expense. Sampling and conformance testing of the Geotextile supplied as replacement for rejected material shall be performed by the Engineer at Contractor's expense.

3.03 INSTALLATION

A. Geotextiles shall be placed to the lines and grades shown on the Drawings. At the time of installation, the Geotextile shall be rejected by the Engineer if it has defects, rips, holes, flaws, evidence of deterioration, or other damage.

B. It is the intent of these Specifications that Geotextiles used to protect natural drainage media be placed the same day as the drainage media to prevent soil, sediment or windblown soils to make contact with the drainage media.

C. The Geotextiles shall be placed smooth and free of excessive wrinkles. Geotextiles shall conform to and be in contact with the approved subgrade.

D. When the Geotextiles are placed on slopes, the upslope fabric portion shall be lapped such that it is the upper or exposed Geotextile.

E. Geotextiles shall be temporarily secured in a manner accepted by the Engineer prior to placement of overlying materials.

F. In the absence of specific requirements shown on the Drawings, the following shall be used for overlaps of adjacent rolls of Geotextile:

| GEOTEXTILE TYPE/ APPLICATION | OVERLAP OF ADJACENT ROLLS[(1)] (INCHES) | TRANSVERSE END OVERLAP (INCHES) |
|---|---|---|
| Filter Geotextile | 6 min | 12 min |
| Cushion Geotextile | 12 min | 12 min |
| Separator-Roadway Applications | 12 min | 24 min |
| Separator-Slope Protection | 18 min | 24 min |
| Separator Geotextile | 12 min | 18 min |

[(1)] Overlaps may be reduced if adjacent panels are sewn or heat bonded where approved by the Engineer.

G. Any Geotextile that is torn or punctured shall be repaired or replaced as directed by the Engineer by the Contractor at no additional cost to the Owner. The repair shall consist of a patch of the same type of Geotextile placed over the failed areas and shall overlap the existing Geotextile a minimum of 12-inches from any point of the rupture.

H. Any Geotextile that is subjected to excessive sediment buildup on its surface during construction shall be replaced by the Contractor prior to placement of overlying material.

TABLE 1 - MINIMUM REQUIRED GEOTEXTILE PROPERTIES*

| GEOTEXTILE PROPERTY | FILTER GEOTEXTILE | CUSHION GEOTEXTILE | TYPE I SEPARATOR GEOTEXTILE | TYPE II SEPARATOR GEOTEXTILE |
|---|---|---|---|---|
| Geotextile Construction | Nonwoven Needlepunched | Nonwoven Needlepunched | Nonwoven Neddlepunched | Woven |
| Mass per Unit Area (Unit Weight), ASTM D5261 ($oz/yd^2$) | 5.6 | 15.7 | 7.8 | N/A |
| Ultraviolet Resistance, (500 hrs.) ASTM D4355, Average % Strength Retention | 70 | 70 | 70 | 70 |
| Grab Tensile Strength (lbs.), ASTM D4632 | 150 | 340 | 200 | $390^{(1)}X250^{(2)}$ |
| Grab Tensile elongation (%) ASTM D4632 | 50 | 50 | 50 | 20 MAX |
| Wide Width Tensile Strength, (lbs./in.) ASTM D4595 | N/A | N/A | N/A | N/A |
| Trapezoid Tear Strength (lbs) ASTM D4533 | 65 | 155 | 90 | 100 |
| Apparent Opening Size (AOS), (mm), ASTM D4751 | 0.25 | N/A | 0.25 | 0.4 |
| Permittivity at 50 mm constant head ($sec^{-1}$), ASTM D4491 | 1.6 | N/A | 1.2 | 0.1 |
| Puncture Resistance, ASTM D6241 (lb) | 430 | 1100 | 575 | 950 |

*** MINIMUM AVERAGE ROLL VALUE (MARV)**

(1) Warp Direction

(2) Fill Direction

- END OF SECTION -

SECTION 02276

SEDIMENT AND EROSION CONTROL

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. Lexington Fayette Urban County Government (LFUCG) Stormwater Manual 2005 Chapter 11, “Erosion and Sediment Control”.

### 1.2 SUMMARY

A. In general, the section includes all of the sediment and erosion control items needed to satisfy the regulatory authorities and may include, but not be limited to the following:

1. Sign and obtain the Notice of Intent.
2. Prepare and maintain a Stormwater Pollution Prevention Plan (SWPPP).
3. Termination of the Notice of Intent.

B. Related Sections include the following:

1. Division 2 Section "Earthwork" for installation of the erosion and sediment control items.

### 1.3 PERFORMANCE REQUIREMENTS

A. Submit Notice of Intent: Fill out, sign and submit the Notice of Intent for the Kentucky Division of Water.

B. Prepare a Stormwater Pollution Prevention Plan (SWPPP); update periodically as site conditions change.

C. Weekly inspection of all erosion and sediment control items. Inspection is also required after rainfalls of 0.5 inches or more.

### 1.4 SUBMITTALS

A. NOI: Submit NOI to KPDES Branch, Division of Water. A copy of the submitted NOI form shall be sent to the Engineer and the Owner.

B. Subcontractor Signatures: Signatures of all subcontractors for approval stating that they have read, understand and that they intend to comply with the SWPPP. A copy of the signatures shall be submitted to the Engineer and the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

A. Continuous Service: The sediment and erosion control items are to be installed prior to the commencement of all other construction activities on site. Continuous maintenance shall be required until the next contract has been signed. To transfer the Notice of Intent, a letter is to be written and signed by the new contractor. Once this letter has been received and approved by the Division of Water the Contractor's responsibility shall be relieved.

B. Prepare Daily Field Reports per SWPPP requirements. Submit to regulatory agency as required.

C. Prepare Erosion and Sediment Control Inspection and Maintenance Report Form weekly per SWPPP requirements.

- END OF SECTION -

SECTION 02500

SURFACE RESTORATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, and materials necessary for final grading, topsoil placement, and miscellaneous site work not included under other Sections but required to complete the work as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 02276 – Sediment and Erosion Control

C. Section 02910 - Final Grading and Landscaping

PART 2 -- MATERIALS

2.01 TOPSOIL

A. Topsoil shall meet the requirements of Section 02200 – Earthwork.

PART 3 -- EXECUTION

3.01 FINAL GRADING

A. Following approval of rough grading the subgrade shall be prepared as follows:

1. For riprap, bare soil 24 inches below finish grade or as directed by Engineer.

2. For topsoil, scarify 2-inches deep at 4 inches below finish grade.

3.02 TOPSOIL PLACEMENT

A. Topsoil shall be placed over all areas disturbed during construction under any contract except those areas which will be paved, graveled or riprapped.

B. Topsoil shall be spread in place for lawn and road shoulder seed areas at a 4-inch consolidated depth and at a sufficient quantity for plant beds and backfill for shrubs and trees.

C. Topsoil shall not be placed in a frozen or muddy condition.

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D. Final surface shall be hand or mechanically raked to an even finished surface to finish grade as shown on Drawings.

E. All stones and roots over 4-inches and rubbish and other deleterious materials shall be removed and disposed of.

- END OF SECTION -

SECTION 02510

PAVING AND SURFACING

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

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

B. Kentucky Transportation Cabinet (KYTC) Standard Specifications for Road and Bridge Construction, latest edition, and Supplemental Specifications to the Standard Specifications.

C. Report of Geotechnical Exploration and Investigation, refer to report.

### 1.2 SUMMARY

A. Related Sections include the following:

1. Division 2 Section "Earthwork" for aggregate subbase and base courses and for aggregate pavement shoulders.

### 1.3 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of the Kentucky Transportation Cabinet (KYTC), except as modified herein.

1. Standard Specification: Kentucky Transportation Cabinet (KYTC) Standard Specifications for Road and Bridge Construction, latest edition, and Supplemental Specifications to the Standard Specifications.

2. Additional Reference: Asphalt Institute MS-2

3. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

### 1.4 SUBMITTALS

A. Job-Mix Designs: For each job mix proposed for the Work.

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1.5 QUALITY ASSURANCE

A. Hot Mix Asphalt Producer Qualifications: Engage a firm experienced in producing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

1. Firm shall be qualified through the Kentucky Transportation Cabinet as an approved Asphalt Paving contractor.

B. Testing and inspection: The owner shall retain a qualified testing laboratory for testing and inspection.

1.6 PROJECT CONDITIONS

***A.*** Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp. Comply with the provisions of KYTC Standard Specifications Section 403.03.01 for temperature requirements. Asphalt Pavement may be placed between November 15$^{th}$ and April 1$^{st}$ if the ambient temperature requirements are met.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4 deg C) for oil-based materials, 50 deg F (10 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound, angular crushed stone, or crushed gravel, complying with KYTC Standard Specifications Section 805.

C. Fine Aggregate: Natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof complying with KYTC Standard Specifications Section 804.

D. Recycled (Reclaimed) Asphalt Pavement (RAP): milled or removed asphalt pavement may be utilized in accordance with KYTC Standard Specifications Section 409.

2.2 ASPHALT MATERIALS.

A. Asphalt Binder: AASHTO MP 1, Performance Graded Binder PG 64-22 for general applications. The contractor may utilize PG 58-22 when asphalt mixture contains more than 15% Recycle Asphalt Pavement (RAP). Note: PG 58-22 is the lowest grade asphalt that should be used in Kentucky.

B. Tack Coat: Comply with provisions in KYTC Standard Specifications Section 406.

2.3 AUXILIARY MATERIALS

A. Pavement-Marking Paint: Alkyd-resin type, ready-mixed, complying with FS TT-P-115, Type I, or AASHTO M-248, Type N.

B. Pavement-Marking Paint: Latex, water-base emulsion, ready-mixed, complying with FS TT-P-1952.

1. Color: White.
2. Color: ADA Blue for all mobility inpaired striping and symbols.

C. Glass Beads: AASHTO M-247.

2.4 MIXES

A. Hot-Mix Asphalt: Hot-laid, hot-mix asphalt plant mixes meeting the requirements of the Standard Specifications of the Kentucky Transportation Cabinet (KYTC) or Asphalt Institute (AI) MS-2 and complying with the following requirements:

1. Base Course: Produce KYTC mixture designation Class 1 Base or a Marshall mixture from AI MS-2. There shall be no restrictions on polish resistant aggregates (utilize KYTC Type “D” aggregates). Recycled Asphalt Pavement (RAP) may be utilized in accordance with KYTC Standard Specifications Section 409.

***2.*** Surface Course: KYTC mixture designation Class 1 Surface or a Marshall mixture from AI MS -2. The mixture gradation may pass through the restricted zone and there shall be no restriction on polish resistant aggregates (utilize KYTC Type “D” aggregates). Recycled Asphalt Pavement (RAP) may be utilized in accordance with KYTC Standard Specifications Section 409.

3. Provide mixes complying with composition, grading, and tolerance requirements in KYTC Standard Specifications or AI MS-2 for the following nominal, maximum aggregate sizes:

a. Base Course: Mixture with a nominal maximum aggregate size of .75 inch (19 mm) with a minimum Voids in the Mineral Aggregate (VMA) of 12 percent.
b. Surface Course: Mixture with a nominal maximum aggregate size of 0.38 inch (9.5 mm) with a minimum VMA of 14 percent.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using loaded dump trucks or heavy rubber-tired construction equipment to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

E. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

### 3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Comply with provisions in KYTC Standard Specifications Section 406.

### 3.3 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Comply with applicable provisions of KYTC Standard Specifications Section 403 for delivery, placement, spreading and compaction of the mixture.

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent.

3.4 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).

2. Surface Course: Plus or minus 1/4 inch (6 mm).

3. Design for a minimum fall of 1% to facilitate drainage (2% recommended)

– END OF SECTION -

SECTION 02604

UTILITY STRUCTURES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, equipment, and tools required for the design, fabrication, delivery and installment of utility structures and appurtenances in accordance with the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 - Earthwork

B. Section 03200 - Reinforcing Steel

C. Section 03250 - Concrete Accessories

D. Section 03300 - Cast-in-Place Concrete

E. Section 03400 - Precast Concrete

F. Section 05540 - Castings

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Federal Specification No. SS-5-00210 - Gaskets

2. ASTM C478 - Specification for Precast Reinforced Concrete Manhole Sections

1.04 SUBMITTALS

A. Submit samples and/or Shop Drawings in accordance with Section 01300, Submittals.

B. In addition to items listed in Section 03400, Precast Concrete, Shop Drawings shall include, but not be limited to:

1. Complete layout and installation Drawings and schedules with clearly marked dimensions.

2. Material certificates on all piping materials.

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3. Structural design calculations sealed by a P.E. registered in Indiana. Design calculations for precast manholes and vaults shall include confirmation structures adequately resist flotation when they are totally empty and subjected to groundwater full height of structure.

4. Results of leakage test

PART 2 -- PRODUCTS

2.01 PRECAST MANHOLES, VAULTS, AND METER BOXES

A. Precast utility structures shall be furnished with waterstops, sleeves and openings as noted on the Drawings. Box out for wall pipes shall conform accurately to the sizes and elevations of the adjoining pipes. Precast utility structures shall be watertight and conform to the requirements of ASTM C 478 with the following modifications there to:

1. Materials shall conform to Section 03400, Precast Concrete.

2. Manholes shall meet the following:

a. Manhole section shall have an internal diameter of 4'-0", unless noted otherwise.

b. Minimum manhole wall thicknesses shall be 5 inches for 4 foot and 5 foot diameter manholes, 6 inches for 6 foot diameter manholes and 7 inches for 7 foot diameter manholes.

c. Manholes shall include ballast concrete and/or other means necessary to insure manholes resist flotation when empty and subjected to groundwater full height of structure.

3. The date and name of manufacturer shall be marked inside each precast section.

4. No more than two lift holes may be cast or drilled in each section.

5. Dimensions shall be as shown on the Drawings.

6. Covers and frames shall be as specified in Section 2.13.

7. Mechanical Details such as piping, electrical, and other details shall be as shown on the Drawings.

B. Joints between manhole riser sections and at base slabs shall be groove type.

2.02 BRICK

A. Brick shall be sound, hard-burned common brick conforming to ASTM C32, Grade MS.

2.03 MORTAR

A. Mortar shall conform to Section 04100 Mortar and Masonry Grout.

2.04 CONCRETE

A. Concrete shall conform to Section 03300, Cast-in-Place Concrete.

2.05 REINFORCING

A. Reinforcing shall conform to Section 03200, Reinforcing Steel.

2.06 PRECAST CONCRETE

A. Precast concrete shall conform to Section 03400, Precast Concrete.

2.07 CONCRETE BLOCK

A. Concrete block shall be solid, rectangular concrete masonry units conforming to ASTM C139.

2.08 CASTINGS

A. Castings shall conform to Section 05540, Castings. Casting shall be of the type and size indicated on the Drawings.

2.09 STEPS

A. Steps shall be constructed of Grade 60 steel reinforcing rod (min. 1/2-inch) and completely encapsulated with a wear resistant and chemical resistant rubber.

B. Each step shall have a minimum vertical load resistance of 800 pounds and a minimum pull-out resistance of 400 pounds.

C. The steps shall have 11-inch minimum tread width and shall be placed at 16-inches on center, as shown on the Drawings.

D. Steps shall be cast in place with the concrete.

E. Steps shall only be installed as shown on the Drawings or required in the Specifications.

2.10 JOINT SEALANT

A. Joint sealant shall be a preformed flexible sealant conforming to the requirements of ASTM C990, paragraph 6.2, Butyl Rubber Sealant. Joint sealant shall be Pro-Stik Butyl Sealant by Press-Seal, Butyl-Nek Join Sealant by Henry, CS-102 Butyl Rubber Sealant for all Precast Structures by ConSeal, or equal.

2.11 FLEXIBLE RUBBER SLEEVE

A. The spring set type shall have a stainless steel interior power sleeve or expander and shall be the PSX assembly by Press-Seal Gasket Corporation, the Kor-N-Seal assembly by National Pollution Control Systems, or Lock Joint Flexible Manhole Sleeve by Interpace Corp.

B. The cast-in-place type shall conform to ASTM C923 and shall include stainless steel take up clamps.

C. Flexible seal assemblies shall permit at least an eight (8) degree deflection from the center line of the opening in any direction while maintaining a watertight connection.

2.12 RUBBER BLADDER

A. The rubber bladder seal shall conform to ASTM C923 suitable for pressure testing at 10 psi minimum, with a 3/8 inch minimum wall thickness.

B. The rubber bladder seal shall contain an environmentally safe, anti-bacterial compound which turns into a high viscosity gel when in contact with pressurized water.

C. The rubber bladder seal shall be NPC Contour Seal by Kor-N-Seal, or equal.

2.13 COVERS AND FRAMES

A. Covers and frames shall comply with Section 05540, Castings and shall be provided by the utility structure manufacturer.

B. Manhole covers and frames shall meet the following requirements:

1. Locate so that there is ready access to the manhole steps

2. Clear opening shall be a minimum of 22 inches, unless otherwise indicated on the Drawings.

3. Watertight manhole frames and covers shall be suitable for 20 psi internal pressure and shall be East Jordan Iron Works Model 1890, or equal.

4. Non-watertight manhole covers shall be perforated and shall be East Jordan Iron Works Model 1945, or equal.

C. Vault covers shall have lifting handles and shall be bolted with stainless steel bolts complying with Section 05050, Metal Fastening.

D. All frames and covers shall be given one shop coat of asphalt or coal tar varnish, unless otherwise specified.

E. Frames and covers shall be identical throughout the Contract.

2.14 GRATES

A. Grates shall comply with Section 05540, Castings.

2.15 CONCRETE BALLAST

A. Concrete ballast shall be Class B concrete in conformance with Section 03300, Cast-in-Place Concrete. Ballast shall be provided as necessary to insure manhole resists flotation when empty and subjected to full height groundwater conditions.

2.16 FLEXIBLE JOINT SEALER

A. Flexible joint sealer shall be a rubber ring waterstop as manufactured by Fernco Joint Sealer Co., or equal.

2.17 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to Section 03250, Concrete Accessories.

PART 3 -- EXECUTION

3.01 DESIGN CRITERIA

A. Precast items subjected to vehicular traffic shall be designed for H-20 traffic loading. Other precast items shall be designed for a vertical live load of 300 psf.

B. Walls of precast items shall be designed for a vertical surcharge of 100 psf.

C. Precast manholes and vaults shall be designed to resist flotation when totally empty and subjected to groundwater full height of the manhole.

3.02 FABRICATION AND CASTING

A. Fabrication and casting shall conform to Section 03400, Precast Concrete, and to Section 03300, Cast-in-Place Concrete.

B. All base sections designated to receive concrete ballast and all electrical manholes shall extend monolithically a minimum of 6 inches beyond the outside face of the wall for the entire periphery. All other utility structures shall have a standard base.

C. Utility structures built around existing pipe shall have a cast-in-place base slab.

3.03 HANDLING, TRANSPORTING, AND STORING

A. Handling, transporting and storing of precast items shall comply with Section 03400, Precast Concrete.

3.04 INSTALLATION

A. Installation shall conform with Section 03400, Precast Concrete and with the manufacturer's recommendations or to Section 03300, Cast-in-Place Concrete.

B. Frames and covers or grates shall be set so that tops are at elevations indicated on the Drawings or flush with finished grade where no elevation is indicated.

C. Joints between riser sections shall be sealed with joint sealant.

D. All openings in utility structures shall have flexible rubber sleeves sized to fit the connecting pipe and installed to provide watertight joints in accordance with the manufacturer's recommendations. The interior of the sleeve shall be filled with Class B concrete.

E. Openings that are too large for flexible rubber sleeves shall Use rubber bladder seals which are expanded by water injected using a pressure pump.

F. All units shall be installed plumb and level.

G. All lift holes and joints shall be filled with non-shrink grout conforming to Section 03600, grout inside and out.

H. The manhole frames shall be set to their required elevations either with grade rings or with two or three courses of brick masonry laid around the top of the upper wall section. Such brick work shall be given a 1-inch mortar coat on the inside and out.

I. Concrete ballast shall be placed so that it bears directly on the utility structure base against the outer wall monolithically encircling the structure for the full height indicated on the Drawings and shall not extend more than 24 inches beyond the edge of the wall. Additional ballast may be required where the depth or elevation of the structure varies from the Drawings.

J. Brick or Concrete Block

Brick or concrete block shall be laid with broken joints and all horizontal and vertical joints filled with cement-sand mortar. Outside of walls shall be plastered with a minimum 1-inch thick coat of cement-sand mortar troweled smooth.

K. Connection to Existing Pipe

1. Verify the diameter and invert elevation of existing pipe to be connected to new utility structures prior to beginning work on the structures.

2. Provide adequate protection to prevent damage to the existing pipe.

3. Provide adequate means for plugging and/or transferring the existing flow in the pipe to allow for the construction of inverts and grouting.

4. Cut off the existing pipe sufficiently for connection to the new structure and remove.

5. Thoroughly clean all foreign matter and coat the pipe surface with epoxy adhesive where the pipe joins the new structure.

6. Install a flexible joint sealer around the pipe.

7. Grout inside and outside of wall penetration with nonshrink grout.

L. Backfill structures in accordance with Section 02200, Earthwork.

M. Clean all structures of any accumulation of silt, debris, or foreign matter and keep clean until final acceptance of the work.

N. Excavation shall conform to Section 02200, Earthwork.

O. Structure bases shall bear on a minimum of 8 inches of compacted stone unless otherwise indicated on the Drawings.

P. Channel Inverts

1. Inverts shall be placed using Class B concrete with forms sufficient to provide a smooth half-round shape as shown on the Drawings. Manhole bases employing full depth precast inverts are acceptable.

2. Where the slope of the line does not change through a manhole, a constant slope shall be maintained in the invert. Where slope changes occur within a given manhole, the transition shall be smooth and shall occur at the approximate center of the manhole.

3. Inverts shown on the Drawings are taken at the center of the manhole unless otherwise noted.

3.05 ADJUSTMENTS TO EXISTING UTILITY STRUCTURES

A. Adjust structures as indicated on the Drawings using concrete or cast iron adjustment rings by approved methods.

B. Clean covers and inlet castings of all foreign material and paint with one coat of coal tar epoxy.

3.06 ADJUSTING COLLARS AND FINAL ADJUSTMENTS

A. Adjusting collars shall be as shown on the Drawings. Final adjustments shall be made so that the manhole ring and cover will be smooth and flush with the finished grade of the adjacent surface, or as otherwise indicated on the Drawings for manholes shown above grade.

3.07 FLUSHING AND TESTING

A. Obstruction - After backfilling, all sewers shall be inspected for obstructions and shall be flushed with water. Flushing shall be a minimum velocity of 2.5 feet per second for a duration acceptable to the Design/Builder. Flushing shall remove all dirt, stones, pieces of wood and other debris which accumulated in the sewer during construction. The Subcontractor shall provide a means acceptable to the Design/Builder for removal of debris

flushed from each section of sewer. If after flushing, any obstructions remain, they shall be removed at the Subcontractor's expense.

B. Visual Inspection - Sewer lines shall be visually inspected from every manhole by use of mirrors, television cameras, or other devices for visual inspection, and the lines shall all exhibit a fully circular pattern when viewed from one manhole to the next. Lines which do not exhibit a true line and grade or have structural defects shall be corrected to meet these qualifications.

C. Leakage - Sewers shall be tested for leakage. The program of testing shall fit the conditions as mutually determined by the Design/Builder and the Subcontractor. The Subcontractor shall take all necessary precautions to prevent any joints from drawing while the sewers or their appurtenances are being tested. The Subcontractor shall, at his own expense, correct any excess leakage and repair any damage to the pipe and their appurtenances, or to any structures resulting from or caused by these tests.

D. Leakage Test Procedure - Each section of sewer shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers and filling the pipe and manhole with water to a point 6 feet above the crown of the open sewer in the upper manhole, or, if ground water is present, 6 feet above the sections average adjacent ground water level as indicated by a monitor well installed adjacent to each manhole. The line shall be filled with water prior to testing and allowed to stand until the pipe has reached its maximum absorption, but not less than two (2) hours. After maximum absorption has been reached, the head shall be re-established and tested for at least six (6) hours maintaining the head specified above by measured additions of water. The sum of these additions shall be the leakage for the test period.

If ground water is present to a height of at least 6 feet above the crown of the sewer at the upper end of the pipe section to be tested, the leakage test may be made by measuring the rate of infiltration using a suitable weir or other measuring device approved by the Design/Builder. Whether the test is made by infiltration or exfiltration, the allowable leakage shall not exceed 100 gallons per day per inch of diameter per mile of sewer being tested.

Where the actual leakage exceeds the allowable, the Subcontractor shall discover the cause and correct it before the sewer will be accepted. For the purpose of this subsection, a section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

E. Low Pressure Compressed Air Test - If the leakage cannot be located by infiltration or exfiltration testing, this type test may be used. The pipeline shall be considered acceptable, when tested at an average pressure of 3.0 psi greater than the average back pressure of any groundwater that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0030 cfm per sq. ft. of internal pipe surface.

F. Deflection Test - No sooner than thirty (30) days after final backfill installation, each section of PVC pipe shall be checked for vertical deflection using an electronic deflecto-meter or a rigid "Go-No-Go" device. Vertical deflection shall not exceed five (5) percent of the inside pipe diameter for PVC pipe.

Where the actual deflection exceeds the allowable, the Subcontractor shall discover the cause and correct it before the pipe will be acceptable. For the purpose of this subsection, a

section of sewer is defined as that length of sewer between successive manholes or special structures or stubouts for future connections.

G. Cost of Testing and Repairs - Any and all work necessary to bring the line into conformance with the infiltration and deflection specifications shall be performed by the Subcontractor at no extra cost to the Owner. All apparent sources of infiltration and excessive deflection shall be repaired by the Subcontractor.

The Subcontractor shall provide all water, plugs, hoses, pumps, equipment, etc. necessary for the proper flushing and testing of the sewers.

- END OF SECTION -

SECTION 02710

STORM DRAINS AND ROOF DRAINS

PART 1 - GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment and materials in connection with the installation of exterior underground storm drains and roof drains as shown on the Contract Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02200 – Earthwork

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

B. ASTM C 150 - Standard Specification for Portland Cement.

C. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

D. AWWA C 110 – Standard Specification for Ductile Iron Pipe & Fittings for Water and Other Liquids.

E. AWWA C 151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.

F. ASTM D 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.

G. ASTM D 3350 – Standard Specifications for Polyethylene Plastic Pipe and Fitting Material.

H. ASTM F 447 – Standard Specifications for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

I. AASHTO M 198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

J. AASHTO M 294 – Standard Specifications for Corrugated Polyethylene Pipe (12” to 36”).

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K. AASHTO Section 30 – Thermoplastic Pipe.

1.04 SUBMITTALS

A. Furnish and submit shop drawings and certificates for the piping work as outlined in the General Conditions and Division 1.

B. Special care shall be exercised during delivery, distribution and storage of the pipe and fittings to prevent damage. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Storage of pipe and fittings, prior to use, shall be in such a manner as to keep the materials clean and dry.

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE (RCP) - CULVERTS

A. Pipe and Fittings

1. Reinforced concrete pipe and fittings shall conform to ASTM Standard C-76, Class III, Wall thickness B, unless otherwise noted on the Contract Drawings. All pipe shall be of the sizes indicated on the drawings. Elliptical reinforcement will not be permitted. All pipe shall be aged at the manufacturing plant for at least fourteen (14) days before delivery to the job site.

B. Joints

1. Pipe may be provided with bell and spigot or tongue and grooved ends. Pipe joints shall be made with rubber gaskets of an approved type and manufacture. Gaskets shall be of the flat or O-ring type. The design of joints and the physical requirements for rubber type gaskets shall conform to ASTM Standard C-443. Joints for the reinforced concrete culvert and drain pipe shall have bell and spigot ends with flexible plastic gaskets meeting the requirements of AASHTO M198, Type B

C. Joint Lubricant

1. Joint lubricant shall be of the type recommended by the manufacturer. Use of petroleum-based lubricants is not permitted.

2.02 Ductile Iron Pipe (DIP) - Roof Drains

A. Pipe

1. Shall be centrifugally cast in metal molds or sand lined molds in accordance with ANSI A21.51 (AWWA C151) of grade 70-50-05 ductile iron. The above standard covers ductile iron pipe with nominal pipe sizes from three (3) inches up to and including fifty-four (54) inches in diameter.

2. Shall have a rated working pressure of 150 psi.

3. Shall be a minimum PC 150.

B. Fittings

1. Shall be manufactured in accordance with ANSI A21.10 (AWWA C110).

2. Shall be manufactured of grade 70 - 50 - 05 ductile iron.

3. Shall have a rated working pressure of 250 psi.

4. Grey iron fittings which conform to the specifications contained herein may be used with ductile iron pipe providing the piping systems minimum working pressure is met or exceeded, and only where ductile iron fittings are not manufactured for a specific fitting.

C. Coatings and Linings for Pipe and Fittings

1. The standard asphaltic coating shall be applied to the exterior wall of the pipe and fittings in accordance with ANSI A21.51 (AWWA C151).

2. The pipe and fittings shall be cement mortar lined to twice the standard thickness in accordance with ANSI A21.4 (AWWA C104) except as specified in the pipe schedule. A seal coat of asphaltic material shall be applied to the mortar lining.

D. Joints

1. Joints shall be push on type in accordance with ANSI A21.11 (AWWA CIII).

2.03 SMOOTH LINED CORRUGATED POLYETHYLENE PIPE - STORM DRAINS

A. General

1. Smooth lined corrugated polyethylene pipe shall be used for storm drains and shall be BLUE SEAL watertight HDPE pipe as manufactured by Hancor, Inc., N-12 WT IB (Watertight) Pipe by ADS, Inc., or approved equal.

B. Pipe and Fittings

1. Smooth lined corrugated polyethylene pipe and fittings shall conform to AASHTO M252-TYPE S for 4" to 10"φ and AASHTO M294 - TYPE S for 12" to 36"φ. All pipes shall be of the sizes indicated on the drawings.

C. Joints

1. Joints shall be watertight bell and spigot type; Hancor, Inc. BLUE SEAL, ADS, Inc. N-12 WT IB, or equal.

D. Foundation Drains

1. Foundation drains shall conform to AASHTO M252-TYPE C. Drains shall have drilled perforations and be Heavy Duty-AASHTO Pipe as manufactured by Hancor, Inc., Single Wall Corrugate Pipe by ADS, Inc., or approved equal.

2.04 BACKFILL MATERIAL

A. Locally available materials shall be used for pipe backfill if Contractor demonstrates the soils meet one of the acceptable soil classifications outlined in Table 1. Imported materials meeting the criteria of Table 1 may also be used.

TABLE 1 – ACCEPTABLE BACKFILL MATERIAL AND COMPACTION REQUIREMENTS

| SOIL CLASSIFICATIONS | | | | |
|---|---|---|---|---|
| DESCRIPTION | ASTM D 2321 | ASTM D 2487 | AASHTO M 43 | Minimum Standard Proctor Density % |
| Graded or crushed, crushed stone, gravel | Class I | -- | 5<br>56 | Dumped |
| Well-graded sand, gravels and gravel/sand mixtures, poorly graded sand, gravels and gravel/sand mixtures; little or no fines | Class II | GW<br>GP<br>SW<br>SP | 57<br>6 | 95% |
| Silty or clayey gravels, gravel/sand/silt or gravel and clay mixtures; silty or clayey sands, sand/clay or sand/silt mixtures | Class III | GM<br>GC<br>SM<br>SC | Gravel and Sand (<10% fines) | 95% |

PART 3 – EXECUTION

3.01 INSPECTION

A. Each length of pipe and fittings delivered to the property shall be inspected by the Contractor, in the presence of the Engineer, for flaws, cracks, dimensional tolerances and compliance with the referenced Standards. The Contractor shall provide the Engineer with suitable templates or calipers for checking pipe dimensions. Only lengths of pipe and fittings accepted by the Engineer and so marked may be installed in the work.

3.02 INSTALLATION

A. Trenching, bedding and backfilling shall be as specified in Section 02225 these Specifications and Section 2.04 Backfill Material of this Specification. Under no condition shall pipe be laid in water or when trench conditions or weather are unsuitable for such work.

B. All pipes and fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists or lowered on skidways in such a manner as to avoid shock. Derricks, ropes or other suitable equipment shall be used for lowering the pipe into the trench. Pipe and fittings shall not be dropped or dumped.

C. Each pipe and fitting shall be inspected before it is lowered into the trench. The interior of the pipe and all joint surfaces shall be thoroughly cleaned and shall thereafter be maintained clean. The open ends of pipe shall be securely plugged whenever pipe laying is not in progress.

D. Pipe and fittings shall be selected so that there will be as small a deviation as possible at the joints and so that inverts present a smooth surface. All joints shall be installed, made up and inspected in accordance with approved printed instructions of the manufacturer. Pipe and fittings which do not fit together to form a tight joint will be rejected.

E. Cutting of reinforced concrete pipe will be permitted only at connections to structures and be accomplished by abrasive saws. Cutting of other pipe materials shall be done only with mechanical cutters and in accordance with the manufacturer's recommendations.

F. Pipe shall be laid accurately to the lines and grades shown on the drawings or as directed by the Engineer.

G. If an adequate foundation for the pipe is not available at the desired depth, additional excavation shall be required and the foundation brought to desired grade with suitable granular material.

H. Rock outcroppings, very soft soils such as muck, and other similar materials not providing proper foundation support shall be removed/replaced with suitable granular material.

I. Bedding material directly under the pipe invert shall be left in native condition and not compacted. Pipe shall be placed on the bedding, then backfilled under the pipe haunches before further backfill is placed.

J. Class I materials may be dumped around pipe. Voids shall be eliminated by knifing under and around the pipe or by other approved technique.

L. Inorganic silts, and gravelly, sandy, or silty clays, and other Class IV materials (not shown in Table 1) shall not be used for pipe backfill.

M. Any section of the pipe that is found defective in material, alignment, grade, joints, or otherwise, shall be satisfactorily corrected by the Contractor at no additional cost to the Owner.

3.03 COMPACTION

A. General

1. Place and assure backfill and fill materials achieve an equal or higher degree of

compaction than undisturbed materials adjacent to the work.

2. In no case shall degree of compaction below “Minimum Compactions” specified be accepted.

B. Compaction Requirements: Unless noted otherwise on the Drawings or more stringently by other sections of these Specifications, comply with following trench compaction criteria:

TABLE 2 – - MINIMUM COMPACTIONS

| LOCATION | SOIL TYPE | DENSITY |
|---|---|---|
| 1. Compacted select backfill: | | |
| All applicable areas | Cohesive soil | 95 percent of maximum dry density by ASTM D698 |
| | Cohensionless soils | 75 percent of maximum relative density by ASTM D4253 and ASTM D4254 |
| 2. Common trench backfill: | | |
| Under pavements roadways surfaces, D698 within highway right-of-ways, adjacent to retaining walls | Cohesive soils | 95 percent of maximum dry density by ASTM D698 |
| | Cohensionless soils | 75 percent of maximum relative density by ASTM D4253 and ASTM D4254 |
| Under turfed, sodded plant seeded, non-traffic areas | Cohesive soils | 95 percent of maximum dry density by ASTM D698 |
| | Cohensionless soils | 75 percent of maximum relative density by ASTM D4253 and ASTM D4254 |

C. Ensure backfill materials have moisture content within three (3) percent of optimum moisture content at the time of placement.

3.04 TESTING

A. General

1. The Contractor shall provide at his own expense, all labor, material, measuring devices and water necessary to perform the required tests. All tests shall be performed in the presence of the Engineer. Disposal of water shall be in accordance with Section 01010.

B. Tests by Manufacturer

1. An infiltration and exfiltration test for the pipe shall be made at the place of manufacture. Certified test results shall be submitted. The infiltration or exfiltration

allowance shall not exceed 250 gallons per inch of pipe diameter per mile per day. One joint test for each two hundred feet of pipe to be furnished.

C. Exfiltration and Infiltration Tests

1. The pipe shall be tested for leakage by exfiltration and/or infiltration tests after installation and back-filling. Exfiltration or infiltration shall not exceed 250 gallons per inch of pipe diameter per mile per day. If the leakage is greater than that volume allowed, the Contractor shall locate and repair or replace defective joints or pipes at his expense until the leakage is within the specified allowance.

2. Exfiltration tests shall be performed on all pipe where the ground- water elevation is one foot above the crown of the pipe or less. Exfiltration tests shall impose a head of at least 2 feet on the pipe at the maximum elevation of the length to be tested. An allowance of an additional 10 percent of gallonage shall be permitted for each additional 2 feet of head over the initial 2 foot minimum. Infiltration tests shall be performed for all other pipe where the groundwater table is greater than one foot above the crown of the pipe.

END OF SECTION

SECTION 02795

PERMEABLE PAVERS

## PART 1 GENERAL

### 1.01 SUMMARY

A. Section Includes

1. Permeable interlocking concrete pavers.
2. Crushed stone bedding material.
3. Open-graded subbase aggregate.
4. Open-graded base aggregate.
5. Bedding and joint/opening filler materials.
6. Edge restraints.
7. Geotextiles

B. Related Sections - Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

### 1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. C 67, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
2. C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C 136, Method for Sieve Analysis for Fine and Coarse Aggregate.
4. C 140, Test Methods for Sampling and Testing Brick and Structural Clay Tile, Section 8 – Freezing and Thawing.
5. D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
6. C 936, Standard Specification for Solid Interlocking Concrete Pavers.
7. C 979, Specification for Pigments for Integrally Colored Concrete.
8. D 698, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 5.5-lb (2.49 kg) Rammer and 12 in. (305 mm) drop.
9. D 1557, Test Methods for Moisture Density Relations of Soil and Soil Aggregate Mixtures Using a 10-lb (4.54 kg) Rammer and 18 in. (457 mm) drop.
10. D 1883, Test Method for California Bearing Ratio of Laboratory-Compacted Soils.
11. D 4254, Standard Test Methods for Minimum Index Density and Unit Weight of

Soils and Calculation of Relative Density.

B. Interlocking Concrete Pavement Institute (ICPI)

1. Permeable Interlocking Concrete Pavement Manual.

1.03 SUBMITTALS

A. In accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Manufacturer's drawing and details: Indicate perimeter conditions, junction with other materials, expansion and control joints, paver layout, patterns, color arrangement, installation and setting details. Indicate layout, pattern, and relationship of paving joints to fixtures and project formed details.

C. Minimum 3 lb (2 kg) samples of subbase, base and bedding aggregate materials.

D. Sieve analysis of aggregates for subbase, base and bedding materials per ASTM C 136.

E. Soils report indicating density test reports, classification, and infiltration rate measured on-site under compacted conditions, and suitability for the intended project.

F. Erosion and sediment control plan.

G. Permeable concrete pavers:

1. Manufacturer's product catalog sheets with specifications.

2. Four representative full-size samples of each paver type, thickness, color, and finish. Submit samples indicating the range of color expected in the finished installation.

3. Accepted samples become the standard of acceptance for the work of this Section.

4. Laboratory test reports certifying compliance of the concrete pavers with ASTM C 936.

5. Manufacturer's material safety data sheets for the safe handling of the specified materials and products.

6. Manufacturer's written quality control procedures including representative samples of production record keeping that ensure conformance of paving products to the project specifications.

H. Paver Installation Subcontractor:

1. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

2. Job references from projects of a similar size and complexity. Provide Owner/Client/Contractor names, postal address, phone, fax, and email address.

3. Written Method Statement and Quality Control Plan that describes material staging and flow, paving direction and installation procedures, including representative reporting forms that ensure conformance to the project specifications.

1.04 QUALITY ASSURANCE

A. Paver Installation Subcontractor Qualifications:

1. Use an installer having successfully completed concrete paver installation similar in design, material and extent indicated on this project.

2. Use an installer holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program.

B. Review the manufacturers' quality control plan, paver installation subcontractor's Method Statement and Quality Control Plan with pre-construction meeting of representatives from the manufacturer, paver installation subcontractor, general contractor, engineer and/or owner's representative.

C. Mock-Ups:

1. Install a 10 ft x 10 ft (3 x 3 m) paver area.

2. Use this area to determine surcharge of the bedding layer, joint sizes, and lines, laying pattern, color and texture of the job.

3. This area will be used as the standard by which the work will be judged.

4. Subject to acceptance by owner, mock-up may be retained as part of finished work.

5. If mock-up is not retained, remove and properly dispose of mock-up.

1.05 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle.

1. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.

2. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift.

3. Unload pavers at job site in such a manner that no damage occurs to the product or existing construction

D Storage and Protection: Store materials in protected area such that they are kept free from mud, dirt, and other foreign materials.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not install in rain or snow.

B. Do not install frozen bedding materials.

1.07 MAINTENANCE

A. Extra materials: Provide 120 square feet additional material for use by owner for maintenance and repair.

B. Pavers shall be from the same production run as installed materials.

PART 2 - PRODUCTS

A. Manufacturer: Reading Rock or approved equal
   1. Contact: Greg Cooper, 4600 Devitt Drive, Cincinnati, OH 45246, phone 1-800-482-6466

B. Permeable Interlocking Concrete Paver Units:
   1. Paver Type: Aqua-Loc or approved equivalent
      a. Material Standard: Comply with ASTM C 936.
      b. Color: Per Owner's selection from full range of manufacturers selection.
      c. Color Pigment Material Standard: Comply with ASTM C 979.
      d. Size: 4.5 inches x 9 inches x 3.125 inches thick.

2.02 PRODUCT SUBSTITUTIONS

A. Substitutions: Only upon review by Engineer, Architect, and Owner

2.03 CRUSHED STONE FILLER, BEDDING, BASE AND SUBBASE

A. Crushed stone with 90% fractured faces, LA Abrasion < 40 per ASTM C 131, minimum CBR of 80% per ASTM D 1883.

B. Do not use rounded river gravel.

C. All stone materials shall be washed with less than 1% passing the No. 200 sieve.

D. Joint/opening filler, bedding, base and subbase: conforming to ASTM D 448 gradation as shown in Tables 1, 2 and 3 below:

Table 1
ASTM No. 8 Grading Requirements
Bedding and Joint/Opening Filler

| Sieve Size | Percent Passing |
|---|---|
| 12.5 mm (1/2 in.) | 100 |
| 9.5 mm (3/8 in.) | 85 to 100 |
| 4.75 mm (No. 4) | 10 to 30 |
| 2.36 mm (No. 8) | 0 to 10 |
| 1.16 mm (No. 16) | 0 to 5 |

Table 2
ASTM No. 57 Base
Grading Requirements

| Sieve Size | Percent Passing |
|---|---|
| 37.5 mm (1 1/2 in.) | 100 |
| 25 mm (1 in.) | 95 to 100 |
| 12.5 mm (1/2 in.) | 25 to 60 |
| 4.75 mm (No. 4) | 0 to 10 |
| 2.36 mm (No. 8) | 0 to 5 |

Table 3
Grading Requirement for ASTM No. 2 Subbase

| Sieve Size | Percent Passing |
|---|---|
| 75 mm (3 in.) | 100 |
| 63 mm (2 1/2 in.) | 90 to 100 |
| 50 mm (2 in.) | 35 to 70 |
| 37.5 mm (1 1/2 in.) | 0 to 15 |
| 19 mm (3/4 in.) | 0 to 5 |

E. Gradation criteria for the bedding and base:

1. $D_{15}$ base stone /$D_{50}$ bedding stone < 5.
2. $D_{50}$ base stone/$D_{50}$ bedding stone > 2.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Acceptance of Site Verification of Conditions:

1. Contractor shall inspect, accept and certify in writing to the paver installation subcontractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.
   a. Verify that subgrade preparation, compacted density and elevations conform to specified requirements.
   b. Provide written density test results for soil subgrade to the Owner, Contractor and paver installation subcontractor.
   c. Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage pipes and inlets.
2. Do not proceed with installation of bedding and interlocking concrete pavers until subgrade soil conditions are corrected by the Contractor or designated subcontractor.

### 3.03 PREPARATION

A. Verify that the soil subgrade is free from standing water.

B. Stockpile joint/opening filler, base and subbase materials such that they are free from standing water, uniformly graded, free of any organic material or sediment, debris, and ready for placement.

### 3.04 INSTALLATION

A. General

1. Any excess thickness of soil applied over the excavated soil subgrade to trap sediment from adjacent construction activities shall be removed before application of the geotextile and subbase materials.
2. Keep area where pavement is to be constructed free from sediment during entire job. Base and bedding materials contaminated with sediment shall be removed and replaced with clean materials.

3. Do not damage drainpipes, overflow pipes, observation wells, or any inlets and other drainage appurtenances during installation. Report any damage immediately to the project engineer.

B. Geotextiles

1. Place on bottom and sides of soil subgrade. Secure in place to prevent wrinkling from vehicle tires and tracks.
2. Overlap a minimum of 12 in. minimum in the direction of drainage.

C. Open-graded subbase and base

1. Moisten, spread and compact the No. 2 subbase in 4 to 6 in. (100 to 150 mm) lifts without wrinkling or folding the geotextile. Place subbase to protect geotextile from wrinkling under equipment tires and tracks.
2. For each lift, make at least two passes in the vibratory mode then at least two in the static mode with a minimum 10 t (10 T) vibratory roller until there is no visible movement of the No. 2 stone. Do not crush aggregate with the roller.
3. The surface tolerance of the compacted No. 2 subbase shall be ±2 1/2 in. (± 65mm) over a 10 ft (3 mm) straightedge.
4. Moisten, spread and compact No. 57 base in 100 mm (4 in.) lift over the compacted No. 2 subbase with a minimum 10 t (10 T) vibratory roller until there is no visible movement of the No. 57 stone. Do not crush aggregate with the roller.
5. The surface tolerance the compacted No. 57 base should not deviate more than. ±1 in. (25 mm) over a 10 ft (3 m) straightedge.

D. Bedding layer

1. Moisten, spread and screed the No. 8 stone bedding material.
2. Fill voids left by removed screed rails with No. 8 stone.
3. The surface tolerance of the screeded No. 8 bedding layer shall be ±3/8 in (10 mm) over a 10 ft (3 m) straightedge.
4. Do not subject screeded bedding material to any pedestrian or vehicular traffic before paving unit installation begins.

E. Permeable interlocking concrete pavers and joint/opening fill material

1. Lay the pavers in the pattern(s) and joint widths shown on the drawings or as selected by the Owner. Maintain straight pattern lines.
2. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to tire traffic shall be no smaller than 1/3 of a whole unit.
3. Cut pavers and place along the edges with a masonry saw.
4. Fill the openings and joints with 3/8” chips.
5. Remove excess aggregate on the surface by sweeping pavers clean.
6 Compact and seat the pavers into the bedding material using a low-amplitude, 75-90 Hz plate compactor capable of at least 4,000 lbs (18 kN) centrifugal compaction force. This will require at least two passes with the plate compactor.

7. Do not compact within 6 ft (2 m) of the unrestrained edges of the paving units.
8. Apply additional aggregate to the openings and joints, filling them completely. Remove excess aggregate by sweeping then compact the pavers. This will require at least two passes with the plate compactor.
9. All pavers within 6 ft (2 m) of the laying face must be left fully compacted at the completion of each day.
10. The final surface tolerance of compacted pavers shall not deviate more than ±3/8 (10 mm) under a 10 ft (3 m) long straightedge.
11. The surface elevation of pavers shall be 1/8 to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

3.05 FIELD QUALITY CONTROL

A. After sweeping the surface clean, check final elevations for conformance to the drawings.

B. Lippage: No greater than 1/8 in. (3 mm) difference in height between adjacent pavers.

C. The surface elevation of pavers shall be 1/8 to 1/4 in. (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

3.06 PROTECTION

A. After work in this section is complete, the Contractor shall be responsible for protecting work from sediment deposition and damage due to subsequent construction activity on the site.

END OF SECTION

SECTION 02910

FINAL GRADING AND LANDSCAPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, equipment, and materials necessary for final grading, topsoiling, seeding, and miscellaneous site work not included under other Sections, but required to complete the work as shown on the Drawings and specified herein. Under this Section, all areas of the project site disturbed by excavation, materials storage, temporary roads, etc., shall be reseeded as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02276 - Erosion and Sedimentation Control.

B. Section 02500 - Surface Restoration.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced subsections of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. Lexington Fayette Urban County Government (LFUCG) Stormwater Manual.

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Product Data

2. Certification of all materials, including source for all materials and seeds.

3. Three (3) copies of composition and germination certification and of test results for grass and prairie seed.

4. Provide detailed care information for all planted materials including grass and prairie mixes.

1.05 QUALITY ASSURANCE

A. Installer of native plantings shall have a minimum of 5 years of experience planting and establishing native plants, and prairies.

B. Provide a minimum of 5 projects showing established prairie plantings.

C. Coordinate planting of all plant species during normal planting cycles for each plant.

PART 2 -- PRODUCTS

2.01 PLANTINGS

A. In areas designated for native plantings, plants shall be native low maintenance varieties, tolerant of site's existing soils and climate without supplemental irrigation or fertilization once established. Source of seeds for native plantings shall be from within 200 miles of the site.

2.02 TOPSOIL

A. Upon completion and approval of the rough grading, the Contractor shall place the topsoil over all areas disturbed during construction under any contract except those areas which will be paved, graveled or rip rapped. Topsoil shall not be placed in a frozen or muddy condition and shall contain no toxic materials harmful to grass growth. Topsoil shall be as defined under Section 02200 - Earthwork.

2.03 WATER

A. Water used in this work shall be suitable for irrigation and free from ingredients harmful to plant life.

B. Hose and other watering equipment required for the Work shall be furnished by the Contractor.

2.04 FERTILIZER

A. Commercial fertilizer for lawn areas shall be complete fertilizer, formula 10-10-10, for lawns and shall conform to the applicable state fertilizer laws. Fertilizer shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guarantee analysis. Any fertilizer which becomes caked or otherwise damaged making it unsuitable for use will not be accepted.

B. Fertilizer shall be applied at the rate of 25 pounds per 1,000 square feet.

2.05 GRASS SEED

A. The seed mixture to be sown shall be in the following proportions:

| Common Name | Proportion By Weight | % Purity | % Germination |
|---|---|---|---|
| Fine Lawn Fescue | 40 | 90 | 85 |
| Chewings Fescue | 25 | 90 | 85 |
| Italian Rye Grass | 20 | 90 | 85 |
| Red Top | 10 | 90 | 85 |
| White Clover | 5 | 95 | 90 |

B. All seed shall be fresh and clean and shall be delivered mixed, in unopened packages, bearing a guaranteed analysis of the seed mixture.

C. Germination must be certified to conform to the following minimums:

| | |
|---|---|
| Purity | 90% |
| Germination | 85% |

2.06 SOD

A. Sod shall be at least 70% Bluegrass, strongly rooted and free of pernicious weeds.

B. It shall be mowed to a height not to exceed 3" before lifting, and shall be of uniform thickness with not over 1-1/2" or less than 1" of soil.

2.07 MULCH

A. Mulch for seeded areas shall be Conwed Hydro Mulch, Silva-Fiber, or equal. It shall be suitable for use in a water slurry or for application with hydraulic equipment.

B. Clean straw is acceptable as mulch. It shall be spread at the rate of one (1) bale per 1,000 feet (approximately 2 inch loose depth).

C. Mulch on slopes steeper than 3:1 and on areas subject to surface water run-off or in drainage ditches shall be held in place with erosion control netting.

2.08 STRAW MULCH

A. Straw used for mulch shall be small grain hay. Hay shall be undamaged, air dry, threshed straw, free of undesirable weed seed. Straw mulch is not required for seeded areas treated with a temporary soil stabilizer.

2.09 TEMPORARY SOIL STABILIZER

A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

2.10 DITCH EROSION RETENTION BLANKET

A. The blanket shall be as specified in Section 02276 - Erosion and Sedimentation Control.

2.14 RIPRAP AND HERBICIDES

A. Herbicides are not allowed in areas designated for native plantings. Control weeds in these areas through mulching in landscape beds and by mowing as recommended to establish prairie and grass areas.

A. Furnish and install sufficient quantity of landscape gravel or riprap to cover over the ground to a minimum 4-inch depth for gravel and 24-inch depth for riprap, unless otherwise noted, or indicated on the Drawings. Also furnish and apply an approved herbicide to the subgrade surface just prior to installing the landscape gravel or riprap.

C. During placing, the stone shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone.

D. All topsoil and vegetative matter shall be removed from the subgrade surfaces prior to the application of the weed killer (herbicide) and to the placement of landscape gravel or riprap. Apply commercial-type herbicide as preemergence control of miscellaneous grasses and broadleaf weeds in granular or liquid form such as "Treflan", "Dymid", or equal. Methods and rates of application shall be in strict compliance to manufacturer's directions and acceptable to the Engineer.

E. The herbicide selected shall be safe for use around ornamental plantings, have long-lasting weed control, and shall be resistant to leaching away under excessive rainfall.

F. A second application of the herbicide shall be made on the surface of the landscape gravel or riprap sometime after the first six (6) months, but not later than 12-months. Same methods and rates apply as specified previously.

PART 3 -- EXECUTION

3.01 GRADING

A. After approval of the rough grading, the Contractor shall commence his preparations of the subgrade for the various major conditions of the work as follows:

1. Bare soil for riprap area at subgrade (24-inches below final grade, or as directed by the Engineer).

2. Topsoil for lawn and road shoulder seed area - scarify 2-inch depth of subgrade (4-inches below final grade) prior to placing topsoil.

B. Final surface grading of the topsoiled, landscape graveled, and riprapped areas shall be mechanically raked or hand raked to an even finished surface alignment.

3.02 TOPSOIL

A. Topsoil shall be spread in place for quantity required for lawn and road shoulder seed areas at 4-inch consolidated depth, and sufficient quantity for certain plant beds and backfill for shrubs and trees as specified.

3.03 SEEDBED PREPARATION

A. Contractor shall prepare all areas to receive temporary or permanent seeding measures prior to planting.

B. Topsoil shall be placed in areas to be seeded and roughened with tracked equipment or other suitable measures. Slopes steeper than 3:1 may be roughened by grooving, furrowing, tracking, or stairstep grading. Slopes flatter than 3:1 should be grooved by disking, harrowing, raking, operating planting equipment on the contour.

C. Soil amendments shall be spread as necessary, and at the rates recommended by seed mix or planting manufacturer. Seeding shall be as per the type and rates specified in this Section. Seed shall be broadcast as soon as possible following roughening, before surface has been sealed by rainfall.

3.04 SEEDING AND GRASS

A. The Contractor shall grow a stand of grass by drill or cultipacker seeder, broadcasting, or hydroseeding on all disturbed areas. The Contractor shall be responsible for the satisfactory growth of grass throughout the period of the one-year guarantee. Lawn areas shall be seeded evenly at the rate of 4 pounds per 1,000 square feet of area, lightly raked, rolled with a 200 pound roller and watered with a fine spray.

B. The Contractor's work shall include the preparation of the topsoil and bare soil seed bed, application of fertilizer, limestone, mulching, inoculant, temporary soil stabilizer, watering, and all other operations necessary to provide a satisfactory growth of sod at the end of the one-year maintenance period. Areas without satisfactory sod at the end of one (1) year shall be replanted until satisfactory growth is obtained and acceptable to the Engineer.

C. All areas to be seeded by hydroseeding shall be done by the hydraulic seeding method including all additives and amendments required. A "Reinco", "Finn", or "Bowie" type hydromulcher with adjustable nozzles and extension hoses, or equal, shall be utilized. General capacity of tank should range from 500 to 2,500 gallons, or as approved by the Engineer.

D. Hydraulic seeding shall be carried out in three steps. Step one shall consist of the application of lime. In step two the seed mixture shall be mixed with the fertilizer, wood cellulose fiber mulch, and any required inoculants and applied to the seed bed. Step three shall consist of application of top dressing during the first spring or fall, whichever comes first, after step two.

E. Top dressing shall consist of a commercial grade fertilizer plus Nitrogen or other analysis as may be recommended by soil testing. Types and application rates of seed mixtures, lime, fertilizer, and wood cellulose fiber mulch, shall be as shown in the Seeding Schedule.

F. Ingredients for the mixture should be dumped into a tank of water and thoroughly mixed to a homogeneous slurry and sprayed out under a minimum of 300-350 pounds pressure, in suitable proportions to accommodate the type and capacity of the hydraulic machine to be used. Applications shall be evenly sprayed over the ground surface. The Contractor shall free the topsoil of stones, roots, rubbish, and other deleterious materials and dispose of same off the site. The bare soil, except existing steep embankment area, shall be rough raked to remove stones, roots, and rubbish over 4 inches in size, and other deleterious materials and dispose of same off the site.

G. No seeding should be undertaken in windy or unfavorable weather, when the ground is too wet to rake easily, or when it is frozen or too dry. Any bare spots shown in two to three weeks shall be recultivated, fertilized at half the rate, raked, seeded, and mulched again by mechanical or hand broadcast method acceptable to the Engineer.

H. Areas that have been seeded with a temporary seed mixture shall be mowed to a height of less than 2-inches and scarified prior to seeding with the permanent seed mixture.

I. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.

J. The Contractor shall water newly seeded areas of the lawn and road shoulder mix once a week until the grasses have germinated sufficiently to produce a healthy turf, or unless otherwise directed by the Engineer. Each watering shall provide three (3) gallons per square yard. The Contractor shall furnish all necessary hoses, sprinklers, and connections.

K. The first and second cutting of the lawn grasses only shall be done by the Contractor. All subsequent cuttings will be done by the Owner's forces in a manner specified by the Contractor.

3.05 SOD

A. After all grading has been completed, the soil shall be irrigated within 12 to 24 hours prior to laying the turfgrass sod. Turfgrass sod shall not be laid on soil that is dry and powdery.

B. The first row of turfgrass sod shall be laid in a straight line, with subsequent rows placed parallel to, and tightly against, each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to insure that the turf is not stretched or overlapped, and that all joints are butted tight in order to prevent voids, which would cause air-drying of the roots.

C. On sloping area where erosion may be a problem, turfgrass sod shall be laid with staggered joints and secured by pegging.

D The Contractor shall be responsible for watering turfgrass sod immediately during and after installation to prevent drying. The turfgrass sod shall be irrigated approximately ½-inch every third day until substantial root development has occurred. Once the turfgrass sod has been established, it shall be irrigated approximately 1-inch per week to prevent dehydration. The Contractor shall be responsible for having adequate water available at the site prior to and during installation of the turfgrass sod.

3.06 DITCH AND SWALE EROSION PROTECTION

A. All ditches and swales indicated on the Drawings shall be lined with an erosion control blanket of single width. The area to be covered shall be properly graded and seeded before the blanket is applied. Installation shall be in accordance with Section 02276 - Erosion and Sedimentation Control.

3.07 MAINTENANCE

A. The Contractor shall be responsible for maintaining all seeded areas through the end of his warranty period. Maintenance shall include but not be limited to, annual fertilization, mowing, repair of seeded areas, irrigation, and weed control. The Contractor shall provide, at his own expense, protection for all seeded areas against trespassing and damage at all times until acceptance of the work. Slopes shall be protected from damage due to erosion, settlement, and other causes and shall be repaired promptly at the Contractor's expense.

B. All seeded areas shall be inspected on a regular basis and any necessary repairs or reseedings made within the planting season, if possible. If the stand should be over 60% damaged, it shall be re-established following the original seeding recommendations. Seeded areas are considered to be permanently stabilized when the density of vegetative cover is 90%.

3.08 CLEANUP

A. The Contractor shall remove from the site all subsoil excavated from his work and all other debris including, but not limited to, branches, paper, and rubbish in all landscape areas, and remove temporary barricades as the work proceeds.

B. All areas shall be kept in a neat, orderly condition at all times. Prior to final acceptance, the Contractor shall clean up the entire landscaped area to the satisfaction of the Engineer.

3.09 SEEDING SCHEDULE

A. Optimum seeding dates are March 1 to May 10 and September 1 to September 30. Permanent seeding done between May 10 and September 1 may need to be irrigated. Contractor may seed outside or beyond optimum seeding dates but may be required to re-seed or over-seed if adequate surface cover is not achieved. The soil surface shall remain well protected with mulch during re-seeding or over-seeding operations. Temporary seed mixtures will be used seeding is necessary at times other than those recommended for permanent seeding. Dormant seeding shall be done when soil temperatures are below 50° F but the soil is not frozen. Frost seeding shall be done in late winter when soils are in freeze-thaw stage. Areas seeded with temporary, dormant, or frost seed mixtures shall be reseeded by the Contractor at no additional cost to the Owner with permanent seed as directed by the Engineer.

- END OF SECTION -

SECTION 03100

CONCRETE FORMWORK

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide materials, labor, and equipment required for the design and construction of all concrete formwork, bracing, shoring and supports in accordance with the provisions of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03200 - Reinforcing Steel

B. Section 03250 - Concrete Accessories

C. Section 03290 - Joints in Concrete

D. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. ACI 318 - Building Code Requirements for Structural Concrete

3. ACI 301 - Specifications for Structural Concrete for Buildings

4. ACI 347 - Recommended Practice for Concrete Formwork

5. U.S. Product Standard for Concrete Forms, Class I, PS 1

6. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Manufacturer's data on proposed form release agent

2. Manufacturer's data on proposed formwork system including form ties

020210BR

1.05 QUALITY ASSURANCE

A. Concrete formwork shall be in accordance with ACI 301, ACI 318, and ACI 347.

PART 2 -- PRODUCTS

2.01 FORMS AND FALSEWORK

A. All forms shall be smooth surface forms unless otherwise specified.

B. Wood materials for concrete forms and falsework shall conform to the following requirements:

1. Lumber for bracing, shoring, or supporting forms shall be Douglas Fir or Southern Pine, construction grade or better, in conformance with U.S. Product Standard PS20. All lumber used for forms, shoring or bracing shall be new material.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Pine high density overlaid (HDO) plywood manufactured especially for concrete formwork and shall conform to the requirements of PS1 for Concrete Forms, Class I, and shall be edge sealed. Thickness shall be as required to support concrete at the rate it is placed, but not less than 5/8-inch thick.

C. Other form materials such as metal, fiberglass, or other acceptable material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line and grade indicated may be submitted to the Engineer for approval, but only materials that will produce a smooth form finish equal or better than the wood materials specified will be considered.

2.02 FORMWORK ACCESSORIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to insure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties, or of other removable form-tie fasteners having a circular cross-section, shall not exceed 7/8-inch, and all such fasteners shall be such as to leave holes of regular shape for reaming.

B. Form ties for water-retaining structures shall have integral waterstops. Removable taper ties may be used when acceptable to the Engineer. A preformed mechanical EPDM rubber plug shall be used to seal the hole left after the removal of the taper tie. Plug shall be X-Plug by the Greenstreak Group, Inc., or approved equal. Friction fit plugs shall not be used.

C. Form release agent shall be a blend of natural and synthetic chemicals that employs a chemical reaction to provide quick, easy and clean release of concrete from forms. It shall not stain the concrete and shall leave the concrete with a paintable surface. Formulation of the form release agent shall be such that it would minimize formation of "bug holes" in cast-in-place concrete.

PART 3 -- EXECUTION

3.01 FORM DESIGN

A. Forms and falsework shall be designed for total dead load, plus all construction live load as outlined in ACI 347. Design and engineering of formwork and safety considerations during construction shall be the responsibility of the Contractor.

B. Forms shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.

C. All forms shall be designed for predetermined placing rates per hour, considering expected air temperatures and setting rates.

3.02 CONSTRUCTION

A. The type, size, quality, and strength of all materials from which forms are made shall be subject to the approval of the Engineer. No falsework or forms shall be used which are not clean and suitable. Deformed, broken or defective falsework and forms shall be removed from the work.

B. Forms shall be smooth and free from surface irregularities. Suitable and effective means shall be provided on all forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Joints between the forms shall be sealed to eliminate any irregularities. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to a practical minimum.

C. Forms shall be true to line and grade, and shall be sufficiently rigid to prevent displacement and sagging between supports. Curved forms shall be used for curved and circular structures. Straight panels joined at angles will not be acceptable for forming curved structures. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. Facing material shall be supported with studs or other backing which shall prevent both visible deflection marks in the concrete and deflections beyond the tolerances specified.

D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1 to 1-1/2 inch diameter polyethylene rod held in position to the underside of the wall form.

E. All vertical surfaces of concrete members shall be formed, and side forms shall be provided for all footings, slab edges and grade beams, except where placement of the concrete against the ground is called for on the Drawings. Not less than 1-inch of concrete shall be added to the thickness of the concrete member as shown where concrete is permitted to be placed against trimmed ground in lieu of forms. Such permission will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

F. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Wood forms shall be constructed for wall openings to facilitate loosening and to counteract swelling of the forms.

G. Adequate clean-out holes shall be provided at the bottom of each lift of forms. Temporary openings shall be provided at the base of column forms and wall forms and at other points to facilitate cleaning and observation immediately before the concrete is deposited. The size, number and location of such clean-outs shall be as acceptable to the Engineer.

H. Construction joints shall not be permitted at locations other than those shown or specified, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. For flush surfaces at construction joints exposed to view, the contact surface of the form sheathing over the hardened concrete in the previous placement shall be lapped by not more than 1 inch. Forms shall be held against hardened concrete to prevent offset or loss of mortar at construction joints and to maintain a true surface.

I. The formwork shall be cambered to compensate for anticipated deflections in the formwork due to the weight and pressure of the fresh concrete and due to construction loads. Set forms and intermediate screed strips for slabs accurately to produce the designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are sufficiently strong to support vibrating screeds or roller pipe screeds if the nature of the finish specified requires the use of such equipment. When formwork is cambered, set screeds to a like camber to maintain the proper concrete thickness.

J. Positive means of adjustment (wedges or jacks) for shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Shores and struts shall be securely braced against lateral deflections. Wedges shall be fastened firmly in place after final adjustment of forms prior to concrete placement. Formwork shall be anchored to shores or other supporting surfaces or members to prevent upward or lateral movement of any part of the formwork system during concrete placement. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

K. Runways shall be provided for moving equipment with struts or legs. Runways shall be supported directly on the formwork or structural member without resting on the reinforcing steel.

3.03 TOLERANCES

A. Unless otherwise indicated in the Contract Documents, formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in ACI 117.

B. Structural framing of reinforced concrete around elevators and stairways shall be accurately plumbed and located within 1/4 in. tolerance from established dimensions.

C. The Contractor shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project, sufficient control points and bench marks to be used for reference purposes to check tolerances. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be

used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

D. Regardless of the tolerances specified, no portion of the building shall extend beyond the legal boundary of the building.

3.04 FORM ACCESSORIES

A. Suitable moldings shall be placed to bevel or round all exposed corners and edges of beams, columns, walls, slabs, and equipment pads. Chamfers shall be 3/4 inch unless otherwise noted.

B. Form ties shall be so constructed that the ends, or end fasteners, can be removed without causing appreciable spalling at the faces of the concrete. After ends, or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 inches from the formed face of the concrete that is exposed to wastewater or enclosed surfaces above the wastewater, and not less than 1 inch from the formed face of all other concrete. Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar as specified in Section 03350 - Concrete Finishing. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete member. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. No snap ties shall be broken off until the concrete is at least three days old. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste.

3.05 APPLICATION - FORM RELEASE AGENT

A. Forms for concrete surfaces that will not be subsequently waterproofed shall be coated with a form release agent. Form release agent shall be applied on formwork in accordance with manufacturer's recommendations.

3.06 INSERTS AND EMBEDDED ITEMS

A. Sleeves, pipe stubs, inserts, anchors, expansion joint material, waterstops, and other embedded items shall be positioned accurately and supported against displacement prior to concreting. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.

3.07 FORM CLEANING AND REUSE

A. The inner faces of all forms shall be thoroughly cleaned prior to concreting. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture. Unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.08 FORM REMOVAL AND SHORING

A. Forms shall not be disturbed until the concrete has attained sufficient strength. Sufficient strength shall be demonstrated by structural analysis considering proposed loads, strength of forming and shoring system, and concrete strength data. Shoring shall not be removed until the supported member has acquired sufficient strength to support its weight and the load upon it. Members subject to additional loads during construction shall be adequately shored to sustain all resulting stresses. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

B. Provided the strength requirements specified above have been met and subject to the Engineer's approval, forms may be removed at the following minimum times. The Contractor shall assume full responsibility for the strength of all such components from which forms are removed prior to the concrete attaining its full design compressive strength. Shoring may be required at the option of the Engineer beyond these periods.

**Ambient Temperature (°F.) During Concrete Placement**

| | Over 95° | 70°-95° | 60°-70° | 50°-60° | Below 50° |
|---|---|---|---|---|---|
| Walls | 5 days | 2 days | 2 days | 3 days | Do not remove until directed by Engineer (7 days minimum) |
| Columns | 7 days | 2 days | 3 days | 4 days | |
| Beam Soffits | 10 days | 7 days | 7 days | 7 days | |
| Elevated Slabs | 12 days | 7 days | 7 days | 7 days | |

C. When, in the opinion of the Engineer, conditions of the work or weather justify, forms may be required to remain in place for longer periods of time.

D. An accurate record shall be maintained by the Contractor of the dates of concrete placings and the exact location thereof and the dates of removal of forms. These records shall be available for inspection at all times at the site, and two copies shall be furnished the Engineer upon completion of the concrete work.

3.09 RESHORING

A. When reshoring is permitted or required the operations shall be planned in advance and subjected to approval by the Engineer.

B. Reshores shall be placed after stripping operations are complete but in no case later than the end of the working day on which stripping occurs.

C. Reshoring for the purpose of early form removal shall be performed so that at no time will large areas of new construction be required to support their own weight. While reshoring is under way, no construction or live loads shall be permitted on the new construction. Reshores shall be tightened to carry their required loads but they shall not be overtightened so that the new construction is overstressed. Reshores shall remain in place until the concrete has reached its specified 28-day strength, unless otherwise specified.

D. For floors supporting shores under newly placed concrete, the original supporting shores shall remain in place or reshores shall be placed. The shoring or reshoring system shall

have a capacity sufficient to resist the anticipated loads and in all cases shall have a capacity equal to at least one-half of the capacity of the shoring system above. Reshores shall be located directly under a reshore position above unless other locations are permitted.

E. In multi-story buildings, reshoring shall extend over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads so the design superimposed loads of the floors supporting shores are not exceeded.

- END OF SECTION -

SECTION 03200

REINFORCING STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. Provide all concrete reinforcing including all cutting, bending, fastening and any special work necessary to hold the reinforcing steel in place and protect it from injury and corrosion in accordance with the requirements of this section.

B. Provide deformed reinforcing bars to be grouted into reinforced concrete masonry walls.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 03400 - Precast Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. CRSI - Concrete Reinforcing Institute Manual of Standard Practice

3. ACI SP66 - ACI Detailing Manual

4. ACI 315 - Details and Detailing of Concrete Reinforcing

5. ACI 318 - Building Code Requirements for Structural Concrete

6. WRI - Manual of Standard Practice for Welded Wire Fabric

7. ASTM A 615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcing

8. ASTM A 1064 - Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Detailed placing and shop fabricating drawings, prepared in accordance with ACI 315 and ACI Detailing Manual - (SP66), shall be furnished for all concrete reinforcing. These drawings shall be made to such a scale as to clearly show joint locations, openings, and the arrangement, spacing and splicing of the bars.

2. Mill test certificates - 3 copies of each.

3. Description of the reinforcing steel manufacturer's marking pattern.

4. Requests to relocate any bars that cause interferences or that cause placing tolerances to be violated.

5. Proposed supports for each type of reinforcing.

6. Request to use splices not shown on the Drawings.

7. Request to use mechanical couplers along with manufacturer's literature on mechanical couplers with instructions for installation, and certified test reports on the couplers' capacity.

8. Request for placement of column dowels without the use of templates.

9. Request and procedure to field bend or straighten partially embedded reinforcing.

10. Certification that all installers of dowel adhesive are certified as Adhesive Anchor Installers in accordance with the ACI-CRSI Anchor Installer Certification Program.

1.05 QUALITY ASSURANCE

A. If requested by the Engineer, the Contractor shall provide samples from each load of reinforcing steel delivered in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests due to material failing initial tests shall be paid by the Contractor.

B. Installer Qualifications for Drilled-In Rebar: Drilled-in rebar shall be installed by an Installer with at least three years of experience performing similar installations. Installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer’s representative for the Installer on the project. Training shall consist of a review of the complete installation process for drilled-in anchors, to include but not be limited to the following:

1. Hole drilling procedure.

2. Hole preparation and cleaning technique.

3. Adhesive injection technique and dispenser training/maintenance.

4. Rebar doweling preparation and installation.

5. Proof loading/torquing.

PART 2 -- PRODUCTS

2.01 REINFORCING STEEL

A. Bar reinforcing shall conform to the requirements of ASTM A 615 for Grade 60 Billet Steel reinforcing. All reinforcing steel shall be from domestic mills and shall have the manufacturer's mill marking rolled into the bar which shall indicate the producer, size, type and grade. All reinforcing bars shall be deformed bars. Smooth reinforcing bars shall not be used unless specifically called for on Drawings.

B. Welded wire fabric reinforcing shall conform to the requirements of ASTM A 1064 and the details shown on the Drawings.

C. A certified copy of the mill test on each load of reinforcing steel delivered showing physical and chemical analysis shall be provided, prior to shipment. The Engineer reserves the right to require the Contractor to obtain separate test results from an independent testing laboratory in the event of any questionable steel. When such tests are necessary because of failure to comply with this Specification, such as improper identification, the cost of such tests shall be borne by the Contractor.

D. Field welding of reinforcing steel will not be allowed.

E. Use of coiled reinforcing steel will not be allowed.

2.02 ACCESSORIES

A. Accessories shall include all necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers and other devices to position reinforcing during concrete placement. Slab bolsters shall have gray plastic-coated legs.

B. Concrete blocks (dobies), used to support and position bottom reinforcing steel, shall have the same or higher compressive strength as specified for the concrete in which it is located.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall develop a tensile strength which exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice. The reinforcing steel and coupler used shall be compatible for obtaining the required strength of the connection.

B. Where the type of coupler used is composed of more than one component, all components required for a complete splice shall be supplied.

C. Hot-forged sleeve type couplers shall not be used. Acceptable mechanical couplers are Dayton Superior Dowel Bar Splicer System by Dayton Superior, Dayton, Ohio. Mechanical

couplers shall only be used where shown on the Drawings or where specifically approved by the Engineer.

2.04 DOWEL ADHESIVE SYSTEM

A. Where shown on the Drawings, reinforcing bars anchored into hardened concrete with a dowel adhesive system shall use a two-component adhesive mix which shall be injected with a static mixing nozzle following manufacturer's instructions. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and reinforcing bar. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. The embedment depth of the bar shall be per manufacturer's recommendations, so as to provide a minimum allowable bond strength that is equal to 125 percent of the yield strength of the bar, unless noted otherwise on the Drawings. The adhesive system shall be "Epcon System G5" as manufactured by ITW Redhead, " HIT HY 150 MAX Injection Adhesive Anchor System" as manufactured by Hilti, Inc. “SET-XP” as manufactured by Simpson Strong-Tie Co. or “PE-1000+” by Powers Fasteners. Engineer's approval is required for use of this system in locations other than those shown on the Drawings. **Fast-set epoxy formulations shall not be acceptable. No or equal products will be considered, unless pre-qualified and approved by Engineer and Owner.**

B. Where identified on the Contract Drawings or for installation of concrete where anchorage failure could present a life-threatening hazard, the adhesive system shall be IBC compliant for use in both cracked and uncracked concrete in all Seismic Design Categories, must comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. The adhesive system shall be “HIT-HY 150 MAX-SD Injection Adhesive Anchoring System” as manufactured by Hilti, Inc. “PE-1000 SD” by Powers Fasteners, “SET-XP” by Simpson Strong-Tie Co. or “Epcon System G5” as manufactured by ITW Redhead. Installation of adhesive system shall be in accordance with manufacturer’s recommendations and as required in Item A above. **Alternate adhesive system shall not be acceptable.**

C. All individuals installing dowel adhesive system shall be certified as an Adhesive Anchor Installer in accordance with the ACI-CRSI Anchor Installation Certification Program.

PART 3 -- EXECUTION

3.01 TEMPERATURE REINFORCING

A. Unless otherwise shown on the Drawings or in the absence of the concrete reinforcing being shown, the minimum cross sectional area of horizontal and vertical concrete reinforcing in walls shall be 0.0033 times the gross concrete area and the minimum cross sectional area of reinforcing perpendicular to the principal reinforcing in slabs shall be 0.0020 times the gross concrete area. Temperature reinforcing shall not be spaced further apart than five times the slab or wall thickness, nor more than 18 inches.

3.02 FABRICATION

A. Reinforcing steel shall be accurately formed to the dimensions and shapes shown on the Drawings and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318, except as modified by the Drawings.

B. The Contractor shall fabricate reinforcing bars for structures in accordance with the bending diagrams, placing lists and placing Drawings.

C. No fabrication shall commence until approval of Shop Drawings has been obtained. All reinforcing bars shall be shop fabricated unless approved by the Engineer to be bent in the field. Reinforcing bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars will not be permitted.

D. Welded wire fabric with longitudinal wire of W9.5 size or smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10 inches. Welded wire fabric with longitudinal wires larger than W9.5 size shall be furnished in flat sheets only.

3.03 DELIVERY, STORAGE AND HANDLING

A. All reinforcing shall be neatly bundled and tagged for placement when delivered to the job site. Bundles shall be properly identified for coordination with mill test reports.

B. Reinforcing steel shall be stored above ground on platforms or other supports and shall be protected from the weather at all times by suitable covering. It shall be stored in an orderly manner and plainly marked to facilitate identification.

C. Reinforcing steel shall at all times be protected from conditions conducive to corrosion until concrete is placed around it.

D. The surfaces of all reinforcing steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of all dirt, grease, loose scale and rust, grout, mortar and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and if necessary recleaned.

3.04 PLACING

A. Reinforcing steel shall be accurately positioned as shown on the Drawings and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. All reinforcing steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers which are strong and rigid enough to prevent any displacement of the reinforcing steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the reinforcing bars without settlement. In no case shall concrete block supports be continuous.

B. The portions of all accessories in contact with the formwork shall be made of plastic or steel coated with a 1/8 inch minimum thickness of plastic which extends at least 1/2 inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms in order to provide the specified concrete coverage.

D. Reinforcing bars additional to those shown on the Drawings, which may be found necessary or desirable by the Contractor for the purpose of securing reinforcing in position, shall be provided by the Contractor at no additional cost to the Owner.

E. Reinforcing placing, spacing, and protection tolerances shall be within the limits specified in ACI 318 except where in conflict with the Building Code, unless otherwise specified.

F. Reinforcing bars may be moved within one bar diameter as necessary to avoid interference with other concrete reinforcing, conduits, or embedded items. If bars are moved more than one bar diameter, or enough to exceed placing tolerances, the resulting arrangement of bars shall be as acceptable to the Engineer.

G. Welded wire fabric shall be supported on slab bolsters spaced not less than 30 inches on centers, extending continuously across the entire width of the reinforcing mat and supporting the reinforcing mat in the plane shown on the Drawings.

H. Reinforcing shall not be straightened or rebent unless specifically shown on the drawings or authorized in writing by the Engineer. Bars with kinks or bends not shown on the Drawings shall not be used. Coiled reinforcement shall not be used.

I. Dowel Adhesive System shall be installed in strict conformance with the manufacturer's recommendations and as required in Article 2.04.A. above. A representative of the manufacturer must be on site when required by the Engineer. Testing of adhesive dowels shall be as indicated below and if the dowels are required to have a hook at the end to be embedded in the new work, an approved mechanical coupler shall be provided at a convenient distance from the face of existing concrete to facilitate the testing.

J. Adhesive Dowel Testing

1. At all locations where adhesive dowel testing is shown on the Drawings, at least 25 percent of all adhesive dowels installed shall be tested to the value indicated on the Drawings, with a minimum of one tested dowel per group. If no test value is indicated on the Drawings but the installed dowel is under direct tension, the Contractor shall notify the Engineer to verify whether anchor load testing is required.

2. Contractor shall submit a plan and schedule indicating locations of dowels to be tested, load test values and proposed dowel testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. The testing equipment shall have a minimum of three support points and shall be of sufficient size to locate the edge of supports no closer than two times the anchor embedment depth from the center of the anchor.

3. Where Contract Documents indicate adhesive dowel design to be the Contractor's responsibility, the Contractor shall submit a plan and schedule indicating locations of dowels to be tested and load test values, sealed by a Professional Engineer currently registered in the State of Kentucky. The Contractor's Engineer shall also submit documentation indicating that the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable.

4. Adhesive Dowel shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the dowel after loading shall be considered a failure. Dowels exhibiting damage shall be removed and replaced. If more than 5 percent of tested dowels fail, then 100 percent of dowels shall be proof tested.

3.05 SPLICING

A. Reinforcing bar splices shall only be used at locations shown on the Drawings. When it is necessary to splice reinforcing at points other than where shown, the splice shall be as acceptable to the Engineer.

B. The length of lap for reinforcing bars, unless otherwise shown on the Drawings shall be in accordance with ACI 318 for a class B splice.

C. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

D. Mechanical splices shall be used only where shown on the drawings or when approved by the Engineer.

E. Couplers which are located at a joint face shall be a type which can be set either flush or recessed from the face as shown on the Drawings. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering. After the concrete is placed, couplers intended for future connections shall be plugged and sealed to prevent any contact with water or other corrosive materials. Threaded couplers shall be plugged with plastic plugs which have an O-ring seal.

3.06 INSPECTION

A. The Contractor shall advise the Engineer of his intentions to place concrete and shall allow him adequate time to inspect all reinforcing steel before concrete is placed.

B. The Contractor shall advise the Engineer of his intentions to place grout in masonry walls and shall allow him adequate time to inspect all reinforcing steel before grout is placed.

3.07 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete without prior approval of the Engineer.

- END OF SECTION -

SECTION 03250

CONCRETE ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor and equipment required to provide all concrete accessories including waterstops, expansion joint material, joint sealants, expansion joint seals, contraction joint inserts, and epoxy bonding agent.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03290 - Joints in Concrete

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Fillers, Sealants, and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

| | | |
|---|---|---|
| 1. | ASTM C881 | Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete |
| 2. | ASTM D412 | Standard Tests for Rubber Properties in Tension |
| 3. | ASTM D 624 | Standard Test method for Rubber Property - Tear Resistance |
| 4. | ASTM D 638 | Standard Test Method for Tensile Properties of Plastics |
| 5. | ASTM D1751 | Standard Specifications for Preformed Expansion Joint fillers for Concrete Paving and Structural Construction (nonextruding and resilient bituminous types) |
| 6. | ASTM D 1752 | Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction |
| 7. | ASTM D 1171 | Standard Test Method for Ozone Resistance at 500 pphm |
| 8. | ASTM D 471 | Standard Test Method for Rubber Properties |

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Manufacturer's literature on all products specified herein including material certifications.

2. Proposed system for supporting PVC waterstops in position during concrete placement

3. Samples of products if requested by the Engineer.

PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) WATERSTOPS

A. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide with a minimum thickness at any point of 3/8 inches.

B. Waterstops for expansion joints shall be ribbed with a center bulb. They shall be 9 inches wide with a minimum thickness at any point of 3/8 inch unless shown or specified otherwise. The center bulb shall have a minimum outside diameter of 1 inch and a minimum inside diameter of 1/2 inch.

C. The waterstops shall be manufactured from virgin polyvinyl chloride plastic compound and shall not contain any scrap or reclaimed material or pigment whatsoever. The properties of the polyvinyl chloride compound used, as well as the physical properties of the waterstops, shall exceed the requirements of the U.S. Army Corps. of Engineers' Specification CRD-C572. The waterstop material shall have an off-white, milky color.

D. The required minimum physical characteristics for this material are:

1. Tensile strength - 1,750 psi (ASTM D-638).

2. Ultimate elongation - not less than 280% (ASTM D-638).

E. No reclaimed PVC shall be used for the manufacturing of the waterstops. The Contractor shall furnish certification that the proposed waterstops meet the above requirements.

F. PVC waterstops shall be as manufactured by BoMetals, Inc., DuraJoint Concrete Accessories, or Sika Greenstreak.

G. All waterstop intersections, both vertical and horizontal, shall be made from factory fabricated corners and transitions. Only straight butt joint splices shall be made in field.

2.02 RETROFIT WATERSTOPS

A. Retrofit waterstops shall be used where specifically shown on Drawings for sealing joints between existing concrete construction and new construction.

B. Retrofit waterstops shall be PVC waterstops fabricated from material as described in Section 2.01 of this Specification.

C. Retrofit waterstop shall be attached to existing concrete surface as shown on Drawings.

D. Use of split waterstop in lieu of specially fabricated retrofit waterstop will not be acceptable.

E. Retrofit Waterstop manufacturer must provide a complete system including all Waterstop, stainless steel anchoring hardware, and epoxy for installation.

F. For construction joints, retrofit waterstop shall be style number 609 by Sika Greenstreak, RF-638 by BoMetals, Inc., Type 18 kit by DuraJoint Concrete Accessories, or approved equal. For expansion joints, retrofit waterstop shall be style number 667 by Sika Greenstreak, Type 18-9 kit by DuraJoint Concrete Accessories, or approved equal.

2.03 CHEMICAL RESISTANT WATERSTOPS

A. Where specifically noted on Contract Drawings, chemical resistant waterstops shall be used instead of PVC waterstops.

B. Chemical resistant waterstops for construction joints shall be ribbed with a center bulb. They shall be 6 inches wide with a minimum thickness at any point of 3/16 inches.

C. Chemical resistant waterstops for expansion joints shall be ribbed tear web. They shall be 9 inches wide with a tear web designed to accommodate 1 inch of free movement minimum.

D. Chemical resistant retrofit waterstop shall be a minimum of 2½" wide along the ribbed side and a minimum 5" wide along the side attached to the existing concrete surface. Retrofit waterstop shall include a centerbulb and shall have a minimum thickness of 3/16". Retrofit waterstop manufacturer shall provide a complete system including waterstop, stainless steel anchoring hardware and epoxy for installation.

E. Chemical resistant waterstops shall be manufactured from a fully crosslinked thermoplastic vulcanizate rubber.

F. Waterstops shall be TPE-R by BoMetals, Inc., Earth Shield TPV/TPE-R by JP Specialties, Inc., Westec TPE-R by Westec Barrier Technologies, or TPE-R by DuraJoint Concrete Accessories.

2.04 HYPALON RUBBER WATERSTOPS

A. Hypalon rubber waterstops shall be Sikadur Combiflex by Sika Corporation or approved equal. Minimum width of waterstop material shall be twelve (12) inches unless shown otherwise on Contract Drawings.

2.05 EXPANDING RUBBER WATERSTOP

A. Expanding rubber shall be designed to expand under hydrostatic conditions. Waterstops shall be Adeka Ultra Seal MC-2010M by Adeka Ultra Seal/OCM, Inc., or Hydrotite CJ-1020-2K by Sika Greenstreak, for concrete thickness greater than nine inches. For thicknesses less than nine inches, Adeka Ultra Seal KBA-1510FF or Hydrotite CJ-1020-2K shall be used.

B. Waterstop shall be a chemically modified natural rubber product with a hydrophilic agent.

C. Waterstop has a stainless steel mesh or coextrusion of non-hydrophilic rubber to direct expansion in the thickness direction and restrict the expansion in the longitudinal direction.

2.06 WATERSTOP ADHESIVE

A. Adhesive between waterstops and existing concrete shall be 20+F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by JGF Adhesives, Sikadur 31 Hi-Mod Gel by Sika Corporation, DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

2.07 JOINT SEALANTS

A. Joint sealants shall comply with Section 07900, Joint Fillers, Sealants, and Caulking.

2.08 EXPANSION JOINT MATERIAL

A. Preformed expansion joint material shall be non-extruding, and shall be of the following types:

1. Type I - Sponge rubber, conforming to ASTM D1752, Type I.

2. Type II - Cork, conforming to ASTM D1752, Type II.

3. Type III - Self-expanding cork, conforming to ASTM D1752, Type III.

4. Type IV - Bituminous fiber, conforming to ASTM Designation D1751.

2.09 EXPANSION JOINT SEAL

A. Expansion Joint Seal System shall consist of a preformed neoprene profile, installed using the same dimensions as the joint gap, bonded with a two-component epoxy adhesive and pressurized during the adhesive cure time.

B. The expansion joint system shall be Hydrozo/Jeene Structural Sealing joint system by Hydrozo/Jeene, Inc.

2.10 CONTRACTION JOINT INSERTS

A. Contraction joint inserts shall be ZipCap Control Joint former by Greenstreak Plastic Products.

2.11 EPOXY BONDING AGENT

A. Epoxy bonding agent shall conform to ASTM C881 and shall be Sikadur 32 Hi-Mod, Sika Corporation, Lyndhurst, N.J.; Euco #452 Epoxy System, Euclid Chemical Company, Cleveland, OH, Concresive LV1 by BASF Construction Chemicals.

2.12 EPOXY RESIN BINDER

A. Epoxy resin binder shall conform to the requirements of ASTM C-881, Type III, Grade 3, Class B and C for epoxy resin binder and shall be Sikadur 23, Low-Mod-Gel, manufactured by the Sika Corporation, Lyndhurst, N.J., Flexocrete Gel manufactured by DuraJoint Concrete Accessories or Euco #352 Gel, Euclid Chemical Company, Concresive Paste LPL or SPL by BASF Construction Chemicals.

PART 3 -- EXECUTION

3.01 PVC AND CHEMICAL RESISTANT WATERSTOPS

A. PVC and chemical resistant waterstops shall be provided in all construction and expansion joints in water bearing structures and at other such locations as required by the Drawings.

B. Waterstops shall be carefully positioned so that they are embedded to an equal depth in concrete on both sides of the joint. They shall be kept free from oil, grease, mortar or other foreign matter. To ensure proper placement, all waterstops shall be secured in correct position at 12" on center along the length of the waterstop on each side, prior to placing concrete. Such method of support shall be submitted to the Engineer for review and approval. Grommets or small pre-punched holes as close to the edges as possible will be acceptable for securing waterstops.

C. Splices in PVC waterstops and chemical resistant waterstops shall be made with a thermostatically controlled heating element. Only straight butt joint splices will be allowed in the field. Factory fabricated corners and transitions shall be used at all intersections. Splices shall be made in strict accordance with the manufacturer's recommended instructions and procedures. At least three satisfactory sample splices shall be made on the site. The Engineer may require tests on these splices by an approved laboratory. The splices shall exhibit not less than 80 percent of the strength of the unspliced material.

D. All splices in waterstops will be subject to rigid review for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, discoloration, charring, and other defects which would reduce the potential resistance of the material to water pressure at any point. All defective joints shall be replaced with material which will pass said review and all faulty material shall be removed from the site and disposed of by the Contractor at no additional cost to the Owner.

E. Retrofit waterstops shall be installed as shown on Contract Drawings using approved waterstop adhesive and Type 316 stainless steel batten bars and expansion anchors.

F. Waterstop installation and splicing defects which are unacceptable include, but are not limited to the following:

1. Tensile strength not less than 80 percent of parent material.

2. Overlapped (not spliced) Waterstop.

3. Misalignment of Waterstop geometry at any point greater than 1/16 inch.

4. Visible porosity or charred or burnt material in weld area.

5. Visible signs of splice separation when splice (24 hours or greater) is bent by hand at sharp angle.

3.02 HYPALON RUBBER AND EXPANDING RUBBER WATERSTOPS

A. Waterstops shall be installed only where shown on the Drawings.

B. Waterstops shall be installed in strict accordance with manufacturer's recommendations.

3.03 WATERSTOP ADHESIVE

A. Adhesive shall be applied to both contact surfaces in strict accordance with manufacturer's recommendations.

B. Adhesive shall be used where waterstops are attached to existing concrete surfaces.

3.04 INSTALLATION OF EXPANSION JOINT MATERIAL AND SEALANTS

A. Type I, II, or III shall be used in all expansion joints in structures and concrete pavements unless specifically shown otherwise on the Drawings. Type IV shall be used in sidewalk and curbing and other locations specifically shown on the Drawings.

B. All expansion joints exposed in the finish work, exterior and interior, shall be sealed with the specified joint sealant. Expansion joint material and sealants shall be installed in accordance with manufacturer's recommended procedures and as shown on the Drawings.

C. Expansion joint material that will be exposed after removal of forms shall be cut and trimmed to ensure a neat appearance and shall completely fill the joint except for the space required for the sealant. The material shall be held securely in place and no concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

D. A bond breaker shall be used between expansion joint material and sealant. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surfaces shall present a clean and even appearance.

E. Type 1 joint sealant shall be used in all expansion and contraction joints in concrete, except where Type 7 or Type 8 is required as stated below, and wherever else specified or shown on the Drawings. It shall be furnished in pour grade or gun grade depending on installation requirements. Primers shall be used as required by the manufacturer. The sealant shall be furnished in colors as directed by the Engineer.

F. Type 8 joint sealant shall be used in all concrete pavements and floors subject to heavy traffic and wherever else specified or shown on the Drawings.

G. Type 7 joint sealant shall be used for all joints in chlorine contact tanks and wherever specified or shown on the Drawings.

3.05 EXPANSION JOINT SEAL

A. The expansion joint seal system shall be installed as shown on the Drawings in strict accordance with the manufacturer's recommendations.

3.06 CONTRACTION JOINT INSERTS

A. For contraction joints in slabs, inserts shall be floated in fresh concrete during finishing.

B. For contraction joints in walls, inserts shall be secured in place prior to casting wall.

C. Inserts shall be installed true to line at the locations of all contraction joints as shown on the Drawings.

D. Inserts shall extend into concrete sufficient depth as indicated on the Drawings or specified in Section 03290, Joints in Concrete.

E. Inserts shall not be removed from concrete until concrete has cured sufficiently to prevent chipping or spalling of joint edges due to inadequate concrete strength.

3.07 EPOXY BONDING AGENT

A. The Contractor shall use an epoxy bonding agent for bonding fresh concrete to existing concrete as shown on the Drawings.

B. Bonding surface shall be clean, sound and free of all dust, laitance, grease, form release agents, curing compounds, and any other foreign particles.

C. Application of bonding agent shall be in strict accordance with manufacturer's recommendations.

D. Fresh concrete shall not be placed against existing concrete if epoxy bonding agent has lost its tackiness.

3.08 EPOXY RESIN BINDER

A. Epoxy resin binder shall be used to seal all existing rebar cut and burned off during demolition operations. Exposed rebar shall be burned back 1/2-inch minimum into existing concrete and the resulting void filled with epoxy resin binder.

- END OF SECTION -

SECTION 03290

JOINTS IN CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. Provide all materials, labor and equipment required for the construction of all joints in concrete specified herein and shown on the Drawings.

B. Types of joints in concrete shall be as follows:

1. Construction Joints - Joints between adjacent concrete placements continuously connected with reinforcement.

2. Expansion Joints - Joints in concrete which allow thermal expansion and contraction of concrete. Reinforcement terminates within concrete on each side of joint.

3. Contraction Joints - Joints formed in concrete to provide a weakened plane in concrete section to control formation of shrinkage cracks.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03250 - Concrete Accessories

C. Section 03300 - Cast-in-Place Concrete

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 - Specifications for Structural Concrete for Buildings

2. ACI 318 - Building Code Requirements for Structural Concrete

3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

021706BR

1. Layout drawings showing location and type of all joints to be placed in each structure.

2. Details of proposed joints in each structure.

PART 2 -- MATERIALS

2.01 MATERIALS

A. All materials required for joint construction shall comply with Section 03250 - Concrete Accessories, and Section 07900 - Joint Fillers, Sealants and Caulking.

PART 3 -- EXECUTION

3.01 CONSTRUCTION JOINTS

A. Construction joints shall be as shown on the Drawings. Otherwise, Contractor shall submit description of the joint and its location to Engineer for approval.

B. Unless noted otherwise on the Drawings, construction joints shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point. In this case, the joints in the girders shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and the top of footings or floor slabs unless noted otherwise on Drawings. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.

C. Maximum distance between horizontal joints in slabs and vertical joints in walls shall be 45'-0". For exposed walls with fluid or earth on the opposite side, the spacing between vertical and horizontal joints shall be a maximum of 25’-0”.

D. All corners shall be part of a continuous placement, and should a construction joint be required, the joint shall not be located closer than five feet from a corner.

E. All reinforcing steel and welded wire fabric shall be continued across construction joints. Keys and inclined dowels shall be provided as shown on the Drawings or as directed by the Engineer. Longitudinal keys shall be provided in all joints in walls and between walls and slabs or footings, except as specifically noted otherwise on the Drawings. Size of keys shall be as shown on the Drawings.

F. All joints in water bearing structures shall have a waterstop. All joints below grade in walls or slabs which enclose an accessible area shall have a waterstop.

3.02 EXPANSION JOINTS

A. Size and location of expansion joints shall be as shown on the Drawings.

B. All expansion joints in water-bearing structures shall have a center-bulb type waterstop. All expansion joints below grade in walls or slabs which enclose an accessible area shall have

a center-bulb type waterstop. Waterstop shall be as shown on Drawings and specified in Section 03250, Concrete Accessories.

3.03 CONTRACTION JOINTS

A. Location of contraction joints shall be as shown on the Drawings.

B. Contraction joints shall be formed with contraction joint inserts as specified in Section 03250, Concrete Accessories.

C. Sawcutting of contraction joints in lieu of forming will not be allowed unless otherwise noted on the Drawings. Where sawcutting is allowed, joints shall be sawed as soon as the concrete can support foot traffic without leaving any impression, normally the same day as concrete is placed and in no case longer than 24 hours after concrete is placed.

D. Unless noted otherwise on Drawings, depth of contraction joints shall be 1-1/2 inches in reinforced concrete and 1/3 of concrete thickness in unreinforced concrete.

3.04 JOINT PREPARATION

A. No concrete shall be allowed to enter the joint or the space for the sealant and destroy the proper functions of the joint.

B. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed by wire brushing, air or light sand blasting.

C. The joint shall be thoroughly clean and free from dirt and debris before the primer and the sealant are applied. Where the finished joint will be visible, masking of the adjoining surfaces shall be carried out to avoid their discoloration. The sealant shall be neatly tooled into place and its finished surface shall present a clean and even appearance.

D. All joints shall be sealed as shown on the Drawings and specified in Section 03250, Concrete Accessories.

- END OF SECTION -

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, equipment, materials and services necessary for the manufacture, transportation and placement of all plain and reinforced concrete work, as shown on the Drawings or as ordered by the Engineer.

B. The requirements in this section shall apply to the following types of concrete:

1. Class A1 Concrete: Normal weight structural concrete to be used in all structures, sidewalks and pavements, except where noted otherwise in the Contract Documents. All concrete shall be Class A1 concrete unless another class is specifically called for on Contract Documents or specified herein.

2. Class A2 Concrete: Normal weight structural concrete to be used for interior slabs where a concrete hardener is required for application after placement of slab.

3. Class A3 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or where specifically requested by Contractor and approved by Engineer. Class A3 concrete shall be similar to Class A1 except Class A3 concrete shall contain a mandatory addition of high range water reducer to aid in placement of concrete.

4. Class A4 Concrete: Normal weight structural concrete to be used where specifically called for on Contract Drawings or areas where specifically requested by Contractor and approved by Engineer. Class A4 concrete is identical to Class A1 concrete except that coarse aggregate specified in Article 2.05 below shall be Size #8 in accordance with ASTM C33. Class A4 concrete may also require a mandatory addition of high range water reducer to aid in placement of concrete.

5. Class A6 Concrete: Normal weight structural concrete used where concrete is placed under pressure (pumped). Class A6 concrete shall be used only where specifically approved by Engineer.

6. Class B Concrete: Normal weight structural concrete used for duct bank encasements, catch basins, fence and guard post embedment, concrete fill, and other areas where specifically noted on Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 - Concrete Formwork

B. Section 03200 - Reinforcing Steel

C. Section 03250 - Concrete Accessories

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D. Section 03290 - Joints in Concrete

E. Section 03350 - Concrete Finishes

F. Section 03370 - Concrete Curing

G. Section 03600 - Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work herein shall conform to or exceed the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

| | | |
|---|---|---|
| 1. | 2012 International Building Code with 2013 Kentucky Amendments | |
| 2. | ACI 214 | Recommended Practice for Evaluation of Strength Test Results of Concrete |
| 3. | ACI 301 | Specifications for Structural Concrete for Buildings |
| 4. | ACI 304 | Guide for Measuring, Mixing, Transporting, and Placing Concrete |
| 5. | ACI 305 | Hot Weather Concreting |
| 6. | ACI 306 | Cold Weather Concreting |
| 7. | ACI 309 | Recommended Practice for Consolidation of Concrete |
| 8. | ACI 318 | Building Code Requirements for Structural Concrete |
| 9. | ACI 350 | Code Requirements for Environmental Engineering Concrete Structures |
| 10. | ASTM C 31 | Standard Methods of Making and Curing Concrete Test Specimens in the Field |
| 11. | ASTM C 33 | Standard Specification for Concrete Aggregates |
| 12. | ASTM C 39 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| 13. | ASTM C42 | Obtaining and Testing Drilled Cores and Sawed Beams of Concrete |
| 14. | ASTM C 88 | Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate |
| 15. | ASTM C 94 | Standard Specification for Ready-Mixed Concrete |

16. ASTM C 114 Standard Test Method for Chemical Analysis of Hydraulic Cement

17. ASTM C 136 Standard Method for Sieve Analysis of Fine and Coarse Aggregate

18. ASTM C 138 Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

19. ASTM C 143 Standard Test Method for Slump of Portland Cement Concrete

20. ASTM C 150 Standard Specification for Portland Cement

21. ASTM C 172 Standard Method of Sampling Fresh Concrete

22. ASTM C 192 Standard Method of Making and Curing Concrete Test Specimens in the Laboratory

23. ASTM C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

24. ASTM C 260 Standard Specification for Air-Entraining Admixtures for Concrete

25. ASTM C 295 Standard Guide for Petrographic Examination of Aggregates for Concrete

26. ASTM C 457 Standard Recommended Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete

27. ASTM C 494 Standard Specification for Chemical Admixtures For Concrete

28. ASTM C 595 Standard Specification for Blended Hydraulic Cements

29. ASTM C 618 Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete

30. ASTM C 989 Standard Specification for Slag Cement for Use in Concrete and Mortars

31. ASTM C 1077 Recommended Practice for Labs Testing Concrete

32. ASTM C 1567 Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)

33. ASTM C 1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Sources of all materials and certifications of compliance with specifications for all materials.

2. Certified current (less than 1 year old) chemical analysis of the Portland Cement or Blended Cement to be used.

3. Certified current (less than 1 year old) chemical analysis of fly ash or slag cement to be used.

4. Aggregate test results showing compliance with required standards, i.e., sieve analysis, aggregate soundness tests, petrographic analysis, mortar bar expansion testing per ASTM C 1567, etc.

5. Manufacturer's data on all admixtures stating compliance with required standards.

6. Concrete mix design for each class of concrete specified herein.

7. Field experience records and/or trial mix data for the proposed concrete mixes for each class of concrete specified herein.

1.05 QUALITY ASSURANCE

A. Tests on materials used in the production of concrete shall be required as specified in PART 2 -- PRODUCTS. These tests shall be performed by an independent testing laboratory approved by the Engineer at no additional cost to the Owner.

B. Trial concrete mixes shall be tested when required in accordance with Article 3.01 at no additional cost to the Owner.

C. Field quality control tests, as specified in Article 3.10, unless otherwise stated, will be performed by a materials testing consultant employed by the Owner. However, the Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the Specifications. Any individual who samples and tests concrete to determine if the concrete is being produced in accordance with this Specification shall be certified as a Concrete Field Testing Technician, Grade I, in accordance with ACI CP-2. Testing laboratory shall conform to requirements of ASTM C-1077.

PART 2 -- PRODUCTS

2.01 HYDRAULIC CEMENT

A. Portland Cement

1. Portland Cement shall be Type II conforming to ASTM C 150. Type I cement may be used provided either fly ash or slag cement is also included in the mix in accordance with Articles 2.02 or 2.03 respectively.

2. When potentially reactive aggregates as defined in Article 2.05 are to be used in concrete mix, cement shall meet the following requirements:

   a. For concrete mixed with only Portland Cement, the total alkalies in the cement (calculated as the percentage of $NA_2O$ plus 0.658 times the percentage of $K_2O$) shall not exceed 0.40%.

   b. For concrete mixed with Portland Cement and an appropriate amount of fly ash (Article 2.02) or slag cement (Article 2.03) the total alkalies in the Portland Cement (calculated as the percentage of $NA_2O$ plus 0.658 times the percentage of $K_2O$) shall not exceed 0.85%.

3. When non-reactive aggregates as defined in Article 2.05 are used in concrete mix, total alkalies in the cement shall not exceed 1.0%.

4. The proposed Portland Cement shall not contain more than 8% tricalcium aluminate and more than 12% tetracalcium aluminoferrite.

B. Blended Cement

1. Blended cements shall be Type IP (Portland Fly Ash Cement) or Type IS (Portland Slag Cement) conforming to ASTM C 595.

2. Type IP cement shall be an interground blend of Portland Cement and fly ash in which the fly ash constituent is between 15% and 25% of the weight of the total blend.

3. Type IS cement shall be an interground blend of Portland Cement and slag cement in which the slag constituent is between 35% and 50% of the weight of the total blend.

4. Fly ash and slag cement used in the production of blended cements shall meet the requirements of Articles 2.02 and 2.03, respectively.

5. When reactive aggregates as defined in Article 2.05 are used in concrete mix, the total alkalies in the Portland Cement (calculated as the percentage of $Na_2O$ plus 0.658 times the percentage of $K_2O$) shall not exceed 0.85%. The percentage of fly ash or slag cement shall be set to meet provisions of Article 2.05.G.2.

C. Different types of cement shall not be mixed nor shall they be used alternately except when authorized in writing by the Engineer. Different brands of cement or the same brand from different mills may be used alternately. A resubmittal will be required if different cements are proposed during the Project.

D. Cement shall be stored in a suitable weather-tight building so as to prevent deterioration or contamination. Cement which has become caked, partially hydrated, or otherwise damaged will be rejected.

2.02 FLY ASH

A. Fly ash shall meet the requirements of ASTM C 618 for Class F, except that the loss on ignition shall not exceed 4%. Fly ash shall also meet the optional physical requirements for uniformity as shown in Table 3 of ASTM C 618.

B. For fly ash to be used in the production of type IP cement, the Pozzolan Activity Index shall be greater than 75% as specified in Table 3 of ASTM C 595.

C. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the fly ash constituent shall be between 15% and 25% of the total weight of the combined Portland Cement and fly ash. The percentage of fly ash shall be set to meet the provisions of Article 2.05.G.2.

D. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

E. Additional fly ash shall not be included in concrete mixed with Type IS or IP cement.

2.03 SLAG CEMENT

A. Slag cement shall meet the requirements of ASTM C 989 including tests for effectiveness of slag in preventing excessive expansion due to alkali-aggregate reactivity as described in Appendix X-3 of ASTM C 989.

B. Where reactive aggregates as defined in Article 2.05 are used in concrete mix, the slag cement constituent shall be between 35% and 40% of the total weight of the combined Portland Cement and slag. The percentage of slag cement shall be set to meet the provisions of Article 2.05.G.2.

C. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, inclusion of fly ash or slag cement in the concrete mix, is mandatory.

D. Additional slag cement shall not be included in concrete mixed with type IS or IP cement.

2.04 WATER

A. Water used for mixing concrete shall be clear, potable and free from deleterious substances such as objectionable quantities of silty organic matter, alkali, salts and other impurities.

B. Water shall not contain more than 100 PPM chloride.

C. Water shall not contain more than 500 PPM dissolved solids.

D. Water shall have a pH in the range of 4.5 to 8.5.

E. Water shall meet requirements of ASTM C 1602.

2.05 AGGREGATES

A. All aggregates used in normal weight concrete shall conform to ASTM C 33.

B. Fine Aggregate (Sand) in the various concrete mixes shall consist of natural or manufactured siliceous sand, clean and free from deleterious substances, and graded within the limits of ASTM C 33.

C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 as graded within the limits given in ASTM C 33 unless otherwise specified.

D. For Class A4 concrete, coarse aggregate shall be Size #8M in accordance with ASTM C33.

E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C 136.

F. Aggregates shall be tested for soundness in accordance with ASTM C 88. The loss resulting after five cycles shall not exceed 10 percent for fine or coarse aggregate when using magnesium sulfate.

G. Non-reactive aggregates shall meet the following requirements:

1. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents of the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

(1) Optically strained, microfractured, or microcrystalline quartz, 5.0%, maximum.

(2) Chert or chalcedony, 3.0%, maximum.

(3) Tridymite or cristobalite, 1.0%, maximum.

(4) Opal, 0.5%, maximum.

(5) Natural volcanic glass in volcanic rocks, 3.0%, maximum.

2. Proposed concrete mix including proposed aggregates shall be evaluated by ASTM C-1567. Mean mortar bar expansions at 16 days shall be less than 0.08%. Tests shall be made using exact proportion of all materials proposed for use on the job in design mix submitted.

H. All aggregates shall be considered reactive unless they meet the requirements above for non-reactive aggregates. Aggregates with a lithology essentially similar to sources in the same region found to be reactive in service shall be considered reactive regardless of the results of the tests above.

I. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.06 ADMIXTURES

A. Air entraining agent shall be added to all concrete unless noted otherwise. The agent shall consist of a neutralized vinsol resin solution or a purified hydrocarbon with a cement catalyst which will provide entrained air in the concrete in accordance with ASTM C 260. The

admixture proposed shall be selected in advance so that adequate samples may be obtained and the required tests made. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.

B. The following admixtures are required or used for water reduction, slump increase, and/or adjustment of initial set. Admixtures permitted shall confirm to the requirements of ASTM C 494. Admixtures shall be non-toxic after 30 days and shall be compatible with and made by the same manufacturer as the air-entraining admixtures.

1. Water reducing admixture shall conform to ASTM C 494, Type A and shall contain no more than 0.05% chloride ions. Acceptable products are “Eucon Series” by the Euclid Chemical Company, “Pozzolith Series” by BASF, and “Plastocrete Series” by Sika Corporation.

2. High range water reducer shall be sulfonated polymer conforming to ASTM C 494, Type F or G. The high range water reducer shall be added to the concrete at either the batch plant or at the job site and may be used in conjunction with a water reducing admixture. The high range water reducer shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day’s operation of the job site system. Concrete shall be mixed at mixing speed for a minimum of 100 mixer revolutions after the addition of the high range water reducer. Acceptable products are “Eucon 37” or Plastol 5000 by the Euclid Chemical Company, “Rheobuild 1000 or Glenium Series” by BASF, and “Daracem 100 or Advaflow Series” by W.R. Grace.

3. A non-chloride, non-corrosive accelerating admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C 494, Type C or E, and shall not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year’s duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Acceptable products are “Accelguard 80/90 or NCA” by the Euclid Chemical Company and “Daraset” by W.R. Grace.

4. A water reducing retarding admixture may be used where specifically approved by the Engineer. The admixture shall conform to ASTM C494, Type D and shall not contain more than 0.05% chloride ions. Acceptable products are “Eucon NR or Eucon Retarder 100” by the Euclid Chemical Company, “Pozzolith Retarder” by BASF, and “Plastiment” by Sika Corporation.

C. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are <u>not</u> permitted. The addition of admixtures to prevent freezing is not permitted.

D. The Contractor shall submit manufacturer's data including the chloride ion content of each admixture and certification from the admixture manufacturer that all admixtures utilized in the design mix are compatible with one another and properly proportioned prior to mix design review by the Engineer.

2.07 CONCRETE MIX DESIGN

A. The proportions of cement, aggregates, admixtures and water used in the concrete mixes shall be based on the results of field experience or preferably laboratory trial mixes in conformance with Section 5.3. "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350. When trial mixes are used they shall also conform to Article 3.01 of this Section of the Specifications. If field experience records are used, concrete strength results shall be from concrete mixed with all of the ingredients proposed for use on job used in similar proportions to mix proposed for use on job. Contractor shall submit verification confirming this stipulation has been followed. Field experience records and/or trial mix data used as the basis for the proposed concrete mix design shall be submitted to the Engineer along with the proposed mix.

B. Structural concrete shall conform to the following requirements. Cementitious materials refer to the total combined weight of all cement, fly ash, and slag cement contained in the mix.

| | | | |
|---|---|---|---|
| 1. | Compressive Strength (28-Day) | | |
| | a. | Concrete Class A1, A2, A3, A4, A6 | 4,500 psi (minimum)<br>6,500 psi (maximum) |
| | b. | Class B | 3,000 psi (minimum) |
| 2. | Maximum water/cementitious materials ratio, by weight | | |
| | a. | Concrete Class A1, A2, A3, A4, A6 | 0.42 |
| | b. | Class B | 0.50 |
| 3. | Slump range | | 4" nominal unless high range water reducing admixture is used. 3" max. before addition of high range water reducing admixture. |
| 4. | Air Content | | |
| | a. | Class A1, A3, A4, A6 | 6% ±1.5% |
| | b. | Class A2, B | 3% Max |

PART 3 -- EXECUTION

3.01 TRIAL MIXES

A. When trial mixes are used to confirm the quality of a proposed concrete mix in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318 and ACI 350, an independent testing laboratory designated and retained by the Contractor and acceptable to the Engineer shall test a trial batch of each of the preliminary concrete mixes submitted by the Contractor. The trial batches shall be prepared using the

aggregates, cement and admixtures proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain enough samples to satisfy requirements stated below. Tests on individual materials stated in PART 2 -- PRODUCTS should already be performed before any trial mix is done. The cost of laboratory trial batch tests for each specified concrete mix will be borne by the Contractor and the Contractor shall furnish and deliver the materials to the testing laboratory at no cost to the Owner.

B. The independent testing laboratory shall prepare a minimum of fifteen (15) standard test cylinders in accordance with ASTM C 31 in addition to conducting slump (ASTM C 143), air content (C 231) and unit weight (C 138) tests. Compressive strength test on the cylinders shall subsequently be performed by the same laboratory in accordance with ASTM C 39 as follows: Test 3 cylinders at age 7 days; test 3 cylinders at age 21 days; test 3 cylinders at age 28 days and test 3 cylinders at 56 days. The cylinders shall be carefully identified as "Trial Mix, Contract No. _____, Product _____." If the average 28-day compressive strength of the trial mix is less than that specified, or if any single cylinder falls below the required strength by more than 500 psi, the mix shall be corrected, another trial batch prepared, test cylinders taken, and new tests performed as before. Any such additional trial batch testing required shall be performed at no additional cost to the Owner. Adjustments to the mix shall be considered refinements to the mix design and shall not be the basis for extra compensation to the Contractor.

3.02 PRODUCTION OF CONCRETE

A. All concrete shall be machine mixed. Hand mixing of concrete will not be permitted. The Contractor may supply concrete from a ready mix plant or from a site mixed plant. In selecting the source for concrete production the Contractor shall carefully consider its capability for providing quality concrete at a rate commensurate with the requirements of the placements so that well bonded, homogenous concrete, free of cold joints, is assured.

B. Ready-Mixed Concrete

1. At the Contractor's option, ready-mixed concrete may be used meeting the requirements for materials, batching, mixing, transporting, and placing as specified herein and in accordance with ASTM C 94.

2. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.

3. Each batch of concrete shall be mixed in a truck mixer for not less than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. All materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

4. Truck mixers and their operation shall be such that the concrete throughout the mixed batch, as discharged, is within acceptable limits of uniformity with respect to consistency, mix and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one inch when the specified slump is 3 inches or less, or if they differ by more than 2 inches

when the specified slump is more than 3 inches, the mixer shall not be used on the work unless the causing condition is corrected and satisfactory performance is verified by additional slump tests. All mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

5. Ready-mixed concrete shall be delivered to the site for the work and discharge shall be completed before the drum has been revolved 300 revolutions and within the time requirements stated in Article 3.03 of this Section.

6. Each and every concrete delivery shall be accompanied by a delivery ticket containing at least the following information:

   a. Date and truck number
   b. Ticket number
   c. Mix designation of concrete
   d. Cubic yards of concrete
   e. Cement brand, type and weight in pounds
   f. Weight in pounds of fine aggregate (sand)
   g. Weight in pounds of coarse aggregate (stone)
   h. Air entraining agent, brand, and weight in pounds and ounces
   i. Other admixtures, brand, and weight in pounds and ounces
   j. Water, in gallons, stored in attached tank
   k. Water, in gallons, maximum that can be added without exceeding design water/cement ratio
   l. Water, in gallons, actually used (by truck driver)
   m. Time of loading
   n. Time of delivery to job (by truck driver)

7. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the above information will be rejected and such truck shall immediately depart from the job site.

8. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

C. Site Mixed Concrete

1. Scales for weighing concrete ingredients shall be accurate when in use within ±0.4 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

2. Operation of batching equipment shall be such that the concrete ingredients are consistently measured within the following tolerances:

| | | |
|---|---|---|
| a. | Cement, fly ash, or slag cement | ± 1 percent |
| b. | Water | ± 1 percent |
| c. | Aggregates | ± 2 percent |

d. Admixtures ± 3 percent

3. Each batch shall be so charged into the mixer that some water will enter in advance of the cement and aggregates. Water shall continue for a period which may extend to the end of the first 25 percent of the specified mixing time. Controls shall be provided to prevent batched ingredients from entering the mixer before the previous batch has been completely discharged.

4. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within the specified mixing time, and of discharging the concrete without harmful segregation. The mixer shall bear a manufacturer's rating plate indicating the rate capacity and the recommended revolutions per minute and shall be operated in accordance therewith.

5. Mixers with a rate capacity of 1 cu.yd. or larger shall conform to the requirements of the Plant Mixer Manufacturers' Division of the Concrete Plant Manufacturers' Bureau.

6. Except as provided below, batches of 1 cu. yd. or less shall be mixed for not less than 1 minute. The mixing time shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity.

7. Shorter mixing time may be permitted provided performance tests made in accordance with of ASTM C 94 indicate that the time is sufficient to produce uniform concrete.

8. Controls shall be provided to insure that the batch cannot be discharged until the required mixing time has elapsed. At least three-quarters of the required mixing time shall take place after the last of the mixing water has been added.

9. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixer blades shall be replaced when they have lost 10 percent of their original height.

10. Air-entraining admixtures and other chemical admixtures shall be charged into the mixer as solutions and shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.

11. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.

12. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first. Retarding admixtures shall not be used unless approved by the Engineer.

13. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C 94.

3.03 CONCRETE PLACEMENT

A. No concrete shall be placed prior to approval of the concrete mix design. Concrete placement shall conform to the recommendations of ACI 304.

B. Prior to concrete placement, all reinforcement shall be securely and properly fastened in its correct position. Formwork shall be clean, oiled and form ties at construction joints shall be retightened. All bucks, sleeves, castings, hangers, pipe, conduits, bolts, anchors, wire, and any other fixtures required to be embedded therein shall be in place. Forms for openings to be left in the concrete shall be in place and anchored by the Contractor. All loose debris in bottoms of forms or in keyways shall be removed and all debris, water, snow, ice and foreign matter shall be removed from the space to be occupied by the concrete. The Contractor shall notify the Engineer in advance of placement, allowing sufficient time for a concurrent inspection and for any corrective measures which are subsequently required.

C. On horizontal joints where concrete is to be placed on hardened concrete, flowing concrete containing a high range water reducing admixture or cement grout shall be placed with a slump not less than 8 inches for the initial placement at the base of the wall. Concrete or cement grout shall meet all strength and service requirements specified herein for applicable class of concrete. This concrete shall be worked well into the irregularities of the hard surface.

D. All concrete shall be placed during the daylight hours except with the consent of the Engineer. If special permission is obtained to carry on work during the night, adequate lighting must be provided.

E. When concrete arrives at the project with slump below that suitable for placing, as indicated by the Specifications, water may be added to bring the concrete within the specified slump range provided that the design water-cement ratio is not exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing required. Water may be added only to full trucks. On-site tempering shall not relieve the Contractor from furnishing a concrete mix that meets all specified requirements.

F. Concrete shall be conveyed as rapidly as practicable to the point of deposit by methods which prevent the separation or loss of the ingredients. It shall be so deposited that rehandling will be unnecessary. Discharge of the concrete to its point of deposit shall be completed within 90 minutes after the addition of the cement to the aggregates. In hot weather, or under conditions contributing to quick stiffening of the concrete, the time between the introduction of the cement to the aggregates and discharge shall not exceed the requirements stated in Article 3.09 of this Section.

G. Where concrete is conveyed to position by chutes, a practically continuous flow in the chute shall be maintained. The angle and discharge arrangement of the chute shall be such as to prevent segregation of the concrete ingredients. The delivery end of the chute shall be as close as possible to the point of deposit and in no case shall the free pour from the delivery end of the chute exceed five feet, unless approved otherwise by Engineer.

H. Special care must be exercised to prevent splashing of forms or reinforcement with concrete, and any such splashes or accumulations of hardened or partially hardened concrete on the forms or reinforcement above the general level of the concrete already in place must be removed before the work proceeds. Concrete shall be placed in all forms in such way as to prevent any segregation.

I. Placing of concrete shall be so regulated that the pressure caused by the wet concrete shall not exceed that used in the design of the forms.

J. All concrete for walls shall be placed through openings in the form spaced at frequent intervals or through tremies (heavy duct canvas, rubber, etc.), equipped with suitable hopper heads. Tremies shall be of variable lengths so the free fall shall not exceed five (5) feet and a sufficient number shall be placed in the form to ensure the concrete is kept level at all times.

K. When placing concrete which is to be exposed, sufficient illumination shall be provided in the interior of the forms so the concrete, at places of deposit, is visible from deck and runways.

L. Concrete shall be placed so as to thoroughly embed all reinforcement, inserts, and fixtures.

M. When forms are removed, surfaces shall be even and dense, free from aggregate pockets or honeycomb. To achieve this, concrete shall be consolidated using mechanical vibration, supplemented by forking and spading by hand in the corners and angle of forms and along form surfaces while the concrete is plastic under the vibratory action. Consolidation shall conform to ACI 309.

N. Mechanical vibration shall be applied directly to the concrete, unless otherwise approved by the Engineer. The bottom of vibrators used on floor slabs must not be permitted to ride the form supporting the slab. Vibration shall be applied at the point of deposit and in the area of freshly placed concrete by a vertical penetration of the vibrator. Vibrators shall not be used to move concrete laterally within the forms.

O. The intensity of vibration shall be sufficient to cause settlement of the concrete into place and to produce monolithic joining with the preceding layer. It shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures with a vibrator transmitting not less than 7,500 impulses per minute. Since the duration of vibration per square foot of surface is dependent on the frequency (impulses per minute), size of vibrator, and slump of concrete, the length of time must therefore be determined in the field. Vibration, however, shall not be continued in any one location to the extent that pools of grout are formed.

P. Care shall be taken to prevent cold joints when placing concrete in any portion of the work. The concrete placing rate shall be such as to ensure that each layer is placed while the previous layer is soft or plastic, so that the two layers can be made monolithic by penetration of the vibrators. Maximum thickness of concrete layers shall be 18 inches. The surface of the concrete shall be level whenever a run of concrete is stopped.

Q. To prevent featheredges, construction joints located at the tops of horizontal lifts near sloping exposed concrete surfaces shall be inclined near the exposed surface, so the angle between such inclined surface and the exposed concrete surface will be not less than 50°.

R. In placing unformed concrete on slopes, the concrete shall be placed ahead of a non-vibrated slip-form screed extending approximately 2-1/2 feet back from its leading edge. The method of placement shall provide a uniform finished surface with the deviation from the straight line less than 1/8 inch in any concrete placement. Concrete ahead of the slip-form screed shall be consolidated by internal vibrators so as to ensure complete filling under

the slip-form. Prior to placement of concrete on sloped walls or slabs, the Contractor shall submit a plan specifically detailing methods and sequence of placements, proposed concrete screed equipment, location of construction joints and waterstops, and/or any proposed deviations from the aforementioned to the Engineer for review and approval.

S. Concrete shall not be placed during rains sufficiently heavy or prolonged to wash mortar from coarse aggregate on the forward slopes of the placement. Once placement of concrete has commenced in a block, placement shall not be interrupted by diverting the placing equipment to other uses.

3.04 PLACING FLOOR SLABS ON GRADE

A. The subgrade for slabs on ground shall be well drained and of adequate and uniform loadbearing nature. The in-place density of the subgrade soils shall be at least the minimum required by the specifications. No foundation, slab, or pavement concrete shall be placed until the depth and character of the foundation soils have been inspected and approved by the materials testing consultant.

B. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a building where concrete is to be placed is below freezing it shall be raised and maintained above 50° long enough to remove all frost from the subgrade.

C. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.

D. Thirty-pound felt paper shall be provided between edges of slab-on-grade and vertical and horizontal concrete surfaces, unless otherwise indicated on the Drawings.

E. Contraction joints shall be provided in slabs-on-grade at locations indicated on the Drawings. Contraction joints shall be installed as per Section 03290 - Joints in Concrete.

F. Floor slabs shall be screeded level or pitched to drain as indicated on the Drawings. Finishes shall conform with requirements of Section 03350 - Concrete Finishes.

3.05 PLACING CONCRETE UNDERWATER (NOT USED)

3.06 PLACING CONCRETE UNDER PRESSURE (CLASS A6 CONCRETE)

A. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall have the capacity for the operation. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. To obtain the least line resistance, the layout of the pipeline system shall contain a minimum number of bends with no change in pipe size. If two sizes of pipe must be used, the smaller diameter should be used at the pump end and the larger at the discharge end. When pumping is completed, the concrete remaining in the pipelines, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

B. Priming of the concrete pumping equipment shall be with cement grout only. Use of specialty mix pump primers or pumping aids will not be allowed.

C. No aluminum parts shall be in contact with the concrete during the entire placing of concrete under pressure at any time.

D. Prior to placing concrete under pressure, the Contractor shall submit the concrete mix design together with test results from a materials testing consultant proving the proposed mix meets all requirements. In addition, an actual pumping test under field conditions is required prior to acceptance of the mix. This test requires a duplication of anticipated site conditions from beginning to end. The batching and truck mixing shall be the same as will be used; the same pump and operator shall be present and the pipe and pipe layouts will reflect the maximum height and distance contemplated. All submissions shall be subject to approval by the Engineer.

E. If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

F. The pumping equipment must have two cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the site during pumping.

G. The minimum diameter of the hose (conduits) shall be four inches.

H. Pumping equipment and hoses (conduits) that are not functioning properly shall be replaced.

I. Concrete samples for quality control in accordance with Article 3.10 will be taken at the placement (discharge) end of the line.

3.07 ORDER OF PLACING CONCRETE

A. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints shown on the Drawings and maximum lengths as indicated on Drawings. Where required on the Drawings and wherever else practical, the placing of such units shall be done in a strip pattern in accordance with ACI 302.1. A minimum of 72 hours shall pass prior to placing concrete directly adjacent to previously placed concrete.

3.08 CONCRETE WORK IN COLD WEATHER

A. Cold weather concreting procedures shall conform to the requirements of ACI 306.

B. The Engineer may prohibit the placing of concrete at any time when air temperature is 40°F. or lower. If concrete work is permitted, the concrete shall have a minimum temperature, as placed, of 55°F. for placements less than 12" thick, 50°F. for placements 12" to 36" thick, and 45°F. for placements greater than 36" thick. The temperature of the concrete as placed shall not exceed the aforementioned minimum values by more than 20°F, unless otherwise approved by the Engineer.

C. All aggregate and water shall be preheated. Precautions shall be taken to avoid the possibility of flash set when aggregate or water are heated to a temperature in excess of 100°F. in order to meet concrete temperature requirements. The addition of admixtures to the concrete to prevent freezing is not permitted. All reinforcement, forms, and concrete accessories with which the concrete is to come in contact shall be defrosted by an approved method. No concrete shall be placed on frozen ground.

3.09 CONCRETE WORK IN HOT WEATHER

A. Hot weather concreting procedures shall conform to the requirements of ACI 305.

B. When air temperatures exceed 85°F., or when extremely dry conditions exist even at lower temperatures, particularly if accompanied by high winds, the Contractor and his concrete supplier shall exercise special and precautionary measures in preparing, delivering, placing, finishing, curing and protecting the concrete mix. The Contractor shall consult with the Engineer regarding such measures prior to each day's placing operation and the Engineer reserves the right to modify the proposed measures consistent with the requirements of this Section of the Specifications. All necessary materials and equipment shall be on hand an in position prior to each placing operation.

C. Preparatory work at the job site shall include thorough wetting of all forms, reinforcing steel and, in the case of slab pours on ground or subgrade, spraying the ground surface on the preceding evening and again just prior to placing. No standing puddles of water shall be permitted in those areas which are to receive the concrete.

D. The temperature of the concrete mix when placed shall not exceed 90°F.

E. Temperature of mixing water and aggregates shall be carefully controlled and monitored at the supplier's plant, with haul distance to the job site being taken into account. Stockpiled aggregates shall, if necessary, be shaded from the sun and sprinkled intermittently with water. If ice is used in the mixing water for cooling purposes, it must be entirely melted prior to addition of the water to the dry mix.

F. Delivery schedules shall be carefully planned in advance so that concrete is placed as soon as practical after it is properly mixed. For hot weather concrete work (air temperature greater than 85°F), discharge of the concrete to its point of deposit shall be completed within 60 minutes from the time the concrete is batched.

G. The Contractor shall arrange for an ample work force to be on hand to accomplish transporting, vibrating, finishing, and covering of the fresh concrete as rapidly as possible.

3.10 QUALITY CONTROL

A. Field Testing of Concrete

1. The Contractor shall coordinate with the Engineer's project representative the on-site scheduling of the materials testing consultant personnel as required for concrete testing.

2. Concrete for testing shall be supplied by the Contractor at no additional cost to the Owner, and the Contractor shall provide assistance to the materials testing consultant in obtaining samples. The Contractor shall dispose of and clean up all excess material.

B. Consistency

1. The consistency of the concrete will be checked by the materials testing consultant by standard slump cone tests. The Contractor shall make any necessary adjustments in the mix as the Engineer and/or the materials testing consultant may

direct and shall upon written order suspend all placing operations in the event the consistency does not meet the intent of the specifications. No payment shall be made for any delays, material or labor costs due to such eventualities.

2. Slump tests shall be made in accordance with ASTM C 143. Slump tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. Concrete with a specified nominal slump shall be placed having a slump within 1" (higher or lower) of the specified slump. Concrete with a specified maximum slump shall be placed having a slump less than the specified slump.

C. Unit Weight

1. Samples of freshly mixed concrete shall be tested for unit weight by the materials testing consultant in accordance with ASTM C 138.

2. Unit weight tests will be performed as deemed necessary by the Engineer and each time compressive strength samples are taken.

D. Air Content

1. Samples of freshly mixed concrete will be tested for entrained air content by the materials testing consultant in accordance with ASTM C 231.

2. Air content tests will be performed as deemed necessary by the materials testing consultant and each time compressive strength samples are taken.

3. In the event test results are outside the limits specified, additional testing shall occur. Admixture quantity adjustments shall be made immediately upon discovery of incorrect air entrainment.

E. Compressive Strength

1. Samples of freshly mixed concrete will be taken by the materials testing consultant and tested for compressive strength in accordance with ASTM C 172, C 31 and C 39, except as modified herein.

2. In general, one sampling shall be taken for each placement in excess of five (5) cubic yards, with a minimum of one (1) sampling for each day of concrete placement operations, or for each one hundred (100) cubic yards of concrete, or for each 5,000 square feet of surface area for slabs or walls, whichever is greater.

3. Each sampling shall consist of at least five (5) 6x12 cylinders or (8) 4x8 cylinders. Each cylinder shall be identified by a tag, which shall be hooked or wired to the side of the container. The materials testing consultant will fill out the required information on the tag, and the Contractor shall satisfy himself that such information shown is correct.

4. The Contractor shall be required to furnish labor to the Owner for assisting in preparing test cylinders for testing. The Contractor shall provide approved curing boxes for storage of cylinders on site. The insulated curing box shall be of sufficient

size and strength to contain all the specimens made in any four consecutive working days and to protect the specimens from falling over, being jarred or otherwise disturbed during the period of initial curing. The box shall be erected, furnished and maintained by the Contractor. Such box shall be equipped to provide the moisture and to regulate the temperature necessary to maintain the proper curing conditions required by ASTM C 31. Such box shall be located in an area free from vibration such as pile driving and traffic of all kinds and such that all specimen are shielded from direct sunlight and/or radiant heating sources. No concrete requiring inspection shall be delivered to the site until such storage curing box has been provided. Specimens shall remain undisturbed in the curing box until ready for delivery to the testing laboratory but not less than sixteen hours.

5. The Contractor shall be responsible for maintaining the temperatures of the curing box during the initial curing of test specimens with the temperature preserved between 60°F and 80°F as measured by a maximum-minimum thermometer. The Contractor shall maintain a written record of curing box temperatures for each day curing box contains test specimens. Temperature shall be recorded a minimum of three times a day with one recording at the start of the work day and one recording at the end of the work day.

6. When transported, the cylinders shall not be thrown, dropped, allowed to roll, or be damaged in any way.

7. Compression tests shall be performed in accordance with ASTM C 39. For 6x12 cylinders, two test cylinders will be tested at seven days and two at 28 days. For 4x8 cylinders, three test cylinders will be tested at seven days, three at 28 days. The remaining cylinders will be held to verify test results, if needed.

F. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be according to the requirements of ACI 214, ACI 318, and ACI 350.

2. The strength level of concrete will be considered satisfactory if all of the following conditions are satisfied.

   a. Every arithmetic average of any three consecutive strength tests equals or exceeds the minimum specified 28-day compressive strength for the mix (see Article 2.07).

   b. No individual compressive strength test results falls below the minimum specified strength by more than 500 psi.

   c. No more than 10% of the compressive tests have strengths greater than the maximum strength specified.

3. In the event any of the conditions listed above are not met, the mix proportions shall be corrected for the next concrete placing operation.

4. In the event that condition 2B is not met, additional tests in accordance with Article 3.10, paragraph H shall be performed.

5. When a ratio between 7-day and 28-day strengths has been established by these tests, the 7-day strengths shall subsequently be taken as a preliminary indication of the 28-day strengths. Should the 7-day test strength from any sampling be more than 10% below the established minimum strength, the Contractor shall:

    a. Immediately provide additional periods of curing in the affected area from which the deficient test cylinders were taken.

    b. Maintain or add temporary structural support as required.

    c. Correct the mix for the next concrete placement operation, if required to remedy the situation.

6. All concrete which fails to meet the ACI requirements and these specifications is subject to removal and replacement at no additional cost to the Owner.

G. When non-compliant concrete is identified, test reports shall be sent immediately to the Engineer for review.

H. Additional Tests

1. When ordered by the Engineer, additional tests on in-place concrete shall be provided and paid for by the Contractor.

2. In the event the 28-day test cylinders fail to meet the minimum strength requirements as outlined in Article 3.10, paragraph F, the Contractor shall have concrete core specimens obtained and tested from the affected area immediately.

    a. Three cores shall be taken for each sample in which the strength requirements were not met.

    b. The drilled cores shall be obtained and tested in conformance with ASTM C 42. The tests shall be conducted by a materials testing consultant approved by the Engineer.

    c. The location from which each core is taken shall be approved by the Engineer. Each core specimen shall be located, when possible, so its axis is perpendicular to the concrete surface and not near formed joints or obvious edges of a unit of deposit.

    d. The core specimens shall be taken, if possible, so no reinforcing steel is within the confines of the core.

    e. The diameter of core specimens should be at least 3 times the maximum nominal size of the course aggregate used in the concrete, but must be at least 2-inches in diameter.

    f. The length of specimen, when capped, shall be at least twice the diameter of the specimen.

    g. The core specimens shall be taken to the laboratory and when transported, shall not be thrown, dropped, allowed to roll, or damaged in any way.

h. Two (2) copies of test results shall be mailed directly to the Engineer. The concrete in question will be considered acceptable if the average compressive strength of a minimum of three test core specimens taken from a given area equal or exceed 85% of the specified 28-day strength and if the lowest core strength is greater than 75% of the specified 28-day strength.

3. In the event that concrete placed by the Contractor is suspected of not having proper air content, the Contractor shall engage a materials testing consultant approved by the Engineer, to obtain and test samples for air content in accordance with ASTM Specification C 457.

4. Concrete placed with compressive strengths greater than the maximum strength specified shall be removed and replaced or repaired as deemed necessary by the Engineer.

3.11 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the Owner. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Care shall be exercised to avoid jarring forms or placing any strain on the ends of projecting reinforcing bars. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed work, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete at no additional cost to the Owner.

B. Areas of honeycomb shall be chipped back to sound concrete and repaired as directed by the Engineer.

C. Concrete formwork blowouts or unacceptable deviations in tolerances for formed surfaces due to improperly constructed or misaligned formwork shall be repaired as directed by the Engineer. Bulging or protruding areas, which result from slipping or deflecting forms shall be ground flush or chipped out and redressed as directed by the Engineer.

D. Areas of concrete in which cracking, spalling, or other signs of deterioration develop prior to final acceptance shall be removed and replaced, or repaired as directed by the Engineer. This stipulation includes concrete that has experienced cracking due to drying or thermal shrinkage of the concrete. Structural cracks shall be repaired using an epoxy injection system approved by the Engineer. Non-structural cracks shall be repaired using a hydrophilic resin pressure injected grout system approved by the Engineer, unless other means of repair are deemed necessary and approved by the Engineer. Extensive repair or replacement will be considered for concrete placed having compressive strengths greater than maximum strength specified. All repair work shall be performed at no additional cost to the Owner.

E. Concrete which fails to meet the strength requirements as outlined in Article 3.10, paragraph F, will be analyzed by the Engineer as to its adequacy based upon loading conditions, resultant stresses and exposure conditions for the particular area of concrete in question. If the concrete in question is found unacceptable based upon this analysis, that

portion of the structure shall be strengthened or replaced by the Contractor at no additional cost to the Owner. The method of strengthening or extent of replacement shall be directed by the Engineer.

- END OF SECTION -

SECTION 03350

CONCRETE FINISHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide finishes of all concrete surfaces specified herein and shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-in-Place Concrete

C. Section 03600 – Grout

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 318 – Building Code Requirements for Structural Concrete

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 – Submittals.

1. Manufacturer's literature on all products specified herein.

PART 2 -- PRODUCTS

2.01 CONCRETE FLOOR SEALER

A. Floor sealer shall be Diamond Clear VOX or Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals.

2.02 CONCRETE LIQUID DENSIFIER AND SEALANT

A. Concrete liquid densifier and sealant shall be a high performance, deeply penetrating concrete densifier and sealant. Product shall be odorless, colorless, VOC-compliant, non-yellowing siliconate based solution designed to harden, dustproof and protect concrete floors subjected to heavy vehicular traffic and to resist black rubber tire marks on concrete

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surfaces. The product must contain a minimum solids content of 20% of which 50% is siliconate. Acceptable products are Diamond Hard by the Euclid Chemical Company and Seal Hard by L&M Construction Chemicals.

2.03 NON-METALLIC FLOOR HARDENER

A. The specified non-metallic mineral aggregate hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a factory-blended mixture of specifically processed graded mineral aggregate, selected Portland cement, and necessary plasticizing agents. Acceptable products shall be "Surflex" by the Euclid Chemical Company, "Harcol" by Sonneborn, "Maximent" by BASF, and "Mastercon" by BASF.

2.04 NON-OXIDIZING HEAVY DUTY METALLIC FLOOR HARDENER

A. Non-oxidizing heavy duty metallic floor hardener shall be formulated, processed, and packaged under stringent quality control at the manufacturer's owned and controlled factory. The hardener shall be a mixture of specifically processed non-rusting aggregate, selected Portland cement, and necessary plasticizing agents. Product shall be "Diamond-Plate" by the Euclid Chemical Company, or Masterplate by BASF Construction Chemicals.

2.05 NON-SLIP FLOORING AGGREGATE

A. Non-slip flooring aggregate for non-slip floors shall be non-metallic. Non-slip flooring aggregate shall be Frictex NS by BASF Construction Chemicals, A-H Alox by Anti-Hydro, or Non-Slip by the Euclid Chemical Company.

PART 3 -- EXECUTION

3.01 FINISHES ON FORMED CONCRETE SURFACES

A. After removal of forms, the finishes described below shall be applied in accordance with Article 3.05 - Concrete Finish Schedule. Unless the finish schedule specifies otherwise, all surfaces shall receive at least a Type I finish. The Engineer shall be the sole judge of acceptability of all concrete finish work.

1. Type I - Rough: All fins, burrs, offsets, marks and all other projections left by the forms shall be removed. Projections, depressions, etc. below finished grade required to be removed will only be those greater than ¼-inch. All holes left by removal of ends of ties, and all other holes, depressions, bugholes, air/blow holes or voids shall be filled solid with cement grout after first being thoroughly wetted and then struck off flush. The only holes below grade to be filled will be tie holes and any other holes larger than ¼-inch in any dimension. Honeycombs shall be chipped back to solid concrete and repaired as directed by the Engineer. All holes shall be filled with tools, such as sponge floats and trowels that will permit packing the hole solidly with cement grout. Cement grout shall consist of one part cement to three parts sand, epoxy bonding agent (for tie holes only) and the amount of mixing water shall be as little as consistent with the requirements of handling and placing. Color of cement grout shall match the adjacent wall surface.

2. Type II - Grout Cleaned: Where this finish is required, it shall be applied after completion of Type I finish. After the concrete has been predampened, a slurry consisting of one part cement (including an appropriate quantity of white cement in order to produce a color matching the surrounding concrete) and 1-1/2 parts sand passing the No. 16 sieve, by damp loose volume, shall be spread over the surface with clean burlap pads or sponge rubber floats. Mix proportions shall be submitted to the Engineer after a sample of the work is established and accepted. Any surplus shall be removed by scraping and then rubbing with clean burlap.

3. Type III - Smooth Rubbed: Where this finish is required, it shall be applied after the completion of the Type I finish. No rubbing shall be done before the concrete is thoroughly hardened and the mortar used for patching is firmly set. A smooth, uniform surface shall be obtained by wetting the surface and rubbing it with a carborundum stone to eliminate irregularities. Unless the nature of the irregularities requires it, the general surface of the concrete shall not be cut into. Corners and edges shall be slightly rounded by the use of the carborundum stone. Brush finishing or painting with grout or neat cement will not be permitted. A 100 square foot example shall be established at the beginning of the project to establish acceptability.

3.02 SLAB AND FLOOR FINISHES

A. The finishes described below shall be applied to floors, slabs, flow channels and top of walls in accordance with Article 3.05 - Concrete Finish Schedule. The Engineer shall be the sole judge of acceptability of all such finish work.

1. Type "A" - Screeded: This finish shall be obtained by placing screeds at frequent intervals and striking off to the surface elevation required. When a Type "F" finish is subsequently to be applied, the surface of the screeded concrete shall be roughened with a concrete rake to 1/2” minimum deep grooves prior to final set.

2. Type "B" - Wood or Magnesium Floated: This finish shall be obtained after completion of a Type "A" finish by working a previously screeded surface with a wood or magnesium float or until the desired texture is reached. Floating shall begin when the water sheen has disappeared and when the concrete has sufficiently hardened so that a person's foot leaves only a slight imprint. If wet spots occur, water shall be removed with a squeegee. Care shall be taken to prevent the formation of laitance and excess water on the finished surface. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finished surface shall be true, even, and free from blemishes and any other irregularities.

3. Type "C" - Cork Floated: This finish shall be similar to Type "B" but slightly smoother than that obtained with a wood float. It shall be obtained by power or band floating with cork floats.

4. Type "D" - Steel Troweled: This finish shall be obtained after completion of a Type "B" finish. When the concrete has hardened sufficiently to prevent excess fine material from working to the surface, the surface shall be compacted and smoothed with not less than two thorough and complete steel troweling operations. In areas which are to receive a floor covering such as tile, resilient flooring, or carpeting, the applicable Specification Sections and Contract Drawings shall be reviewed for the required finishes and degree of flatness. In areas that are intermittently wet such as

pump rooms, only one troweling operation is required to provide some trowel marks for slip resistance. All edges shall be edged with an 1/8-inch tool as directed by the Engineer. The finish shall be brought to a smooth, dense surface, free from defects and blemishes.

5. Type "E" - Broom or Belt: This finish shall provide the surface with a transverse scored texture by drawing a broom or burlap belt across the surface immediately after completion of a Type "B" finish. All edges shall be edged with an 1/8-inch tool as directed by the Engineer.

6. Type "F" - Swept in Grout Topping: This finish shall be applied after a completion of a Type "A" finish. The concrete surface shall be properly cleaned, washed, and coated with a mixture of water and Portland Cement. Cement grout in accordance with Section 03600 shall then be plowed and swept into neat conformance with the blades or arms of the apparatus by turning or rotating the previously positioned mechanical equipment. Special attention shall be paid to true grades, shapes and tolerances as specified by the manufacturer of the equipment. Before beginning this finish, the Contractor shall notify the Engineer and the equipment manufacturer of the details of the operation and obtain approval and recommendations.

7. Type “G” Hardened Finish: This finish shall be applied after completion of a Type “B” or Type “C” finish and prior to application of a Type “D” finish. Hardeners shall be applied in strict accordance with the manufacturer’s requirements. Hardeners shall be applied using a mechanical spreader. The hardener shall be applied in two shakes with the first shake comprising 2/3 of the total amount. Type “D” finish shall be applied following completion of application of the hardener.

   a. Non-metallic floor hardener shall be applied where specifically required on the Contract Drawings at the rate of 1.0 pounds/ft.$^2$.

   b. Non-oxidizing heavy duty metallic floor hardener shall be applied at the loading docks and where specifically required on the Contract Drawings or specified herein at the rate of 1.5 pounds/ft.$^2$.

8. Type "H" - Non-Slip Finish: This finish shall be provided by applying a non-slip flooring aggregate concurrently with the application of a Type "D" finish. Application procedure shall be in accordance with manufacturer's instructions. Finish shall be applied where specifically required on the Contract Drawings or specified herein.

9. Type "J" - Raked Finish: This finish shall be provided by raking the surface as soon as the condition of the concrete permits by making depressions of ±1/4 inch.

3.03 CONCRETE SEALERS

A. Concrete sealers shall be applied where specifically required on the Contract Drawings or specified herein.

B. Sealers shall be applied after installation of all equipment, piping, etc. and after completion of any other related construction activities. Application of sealers shall be in strict accordance with manufacturer’s requirements.

C. Sealers shall be applied to all floor slabs not painted and not intended to be immersed.

D. Floor slabs subjected to vehicular traffic shall be sealed with the concrete liquid densifier and sealer.

E. All other floor slabs to receive sealer shall be sealed with concrete floor sealer.

3.04 FINISHES ON EQUIPMENT PADS

A. Formed surfaces of equipment pads shall receive a Type III finish.

B. Top surfaces of equipment pads, except those surfaces subsequently required to receive grout and support equipment bases, shall receive a Type "D" finish, unless otherwise noted. Surfaces which will later receive grout shall, before the concrete takes its final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with irregular indentations in the surface up to 1/2 inch deep.

3.05 CONCRETE FINISH SCHEDULE

| Item | Type of Finish |
|---|---|
| Concrete surfaces indicated to receive textured coating (as noted on Drawings and in Section 09800, Special Coatings) | I |
| Inner face of walls of tanks, flow channels, wet wells, perimeter walls, and miscellaneous concrete structures: | |
| From 1 feet below water surface to bottom of wall | II |
| From top of wall to 1 feet below water surface | II |
| Exterior concrete walls below grade | I |
| Exterior exposed concrete walls, ceilings, beams, manholes, hand holes, miscellaneous structures and columns (including top of wall) to one foot below grade. All other exposed concrete surfaces not specified elsewhere | II |
| All interior exposed concrete walls and vertical surfaces | III |
| Interior exposed ceiling, including beams | III |
| Floors of process equipment tanks or basins, wetwells, flow channels and slabs to receive roofing material or waterproof membranes | B |
| All interior finish floors of buildings and structures and walking surfaces which will be continuously or intermittently wet | D |
| All interior finish floors of buildings and structures which are not continuously or intermittently wet | D |
| Floors to receive tile, resilient flooring, or carpeting | D |
| Exterior concrete sidewalks, steps, ramps, decks, slabs on grade and landings exposed to weather | E |
| Floors of process equipment tanks indicated on Drawings to receive grout topping | F |
| Garage, storage area floors, and loading docks | G |

| Item | Type of Finish |
|---|---|
| Precast concrete form panels, hollow core planks, double tees | J |

- END OF SECTION -

SECTION 03370

CONCRETE CURING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Protect all freshly deposited concrete from premature drying and from the weather elements. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for a period of time necessary for the hydration of the cement and proper hardening of the concrete in accordance with the requirements specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03100 – Concrete Formwork

B. Section 03300 – Cast-In-Place Concrete

C. Section 03350 – Concrete Finishes

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 301 – Specifications for Structural Concrete for Buildings

2. ACI 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete

3. ACI 305 – Hot Weather Concreting

4. ACI 306 – Cold Weather Concreting

5. ACI 308 – Standard Practice for Curing Concrete

6. ASTM C171 – Standard Specifications for Sheet Materials for Curing Concrete

7. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

8. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

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1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Proposed procedures for protection of concrete under wet weather placement conditions.

2. Proposed normal procedures for protection and curing of concrete.

3. Proposed special procedures for protection and curing of concrete under hot and cold weather conditions.

4. Proposed method of measuring concrete surface temperature changes.

5. Manufacturer's literature and material certification for proposed curing compounds.

## PART 2 -- PRODUCTS

### 2.01 LIQUID MEMBRANE-FORMING CURING COMPOUND

A. Clear curing and sealing compound shall be a clear styrene acrylate type complying with ASTM C 1315, Type 1, Class A with a minimum solids content of 30%. Moisture loss shall not be greater than 0.40 kg/$m^2$ when applied at 300 sq.ft./gal. Manufacturer's certification is required. Acceptable products are Super Diamond Clear VOX by the Euclid Chemical Company, Sonneborn Kure N Seal 30 by BASF Construction Chemicals, and Cure & Seal 30 Plus by Symons Corporation.

B. Where specifically approved by Engineer, on slabs to receive subsequent applied finishes, compound shall conform to ASTM C 309. Acceptable products are "Kurez DR VOX" or "Kurez W VOX" by the Euclid Chemical Company. Install in strict accordance with manufacturer's requirements.

### 2.02 EVAPORATION REDUCER

A. Evaporation reducer shall be BASF, "Confilm", or Euclid Chemical "Euco-Bar".

## PART 3 -- EXECUTION

### 3.01 PROTECTION AND CURING

A. All freshly placed concrete shall be protected from the elements, flowing water and from defacement of any nature during construction operations.

B. As soon as the concrete has been placed and horizontal top surfaces have received their required finish, provision shall be made for maintaining the concrete in a moist condition for at least a 5-day period thereafter except for high early strength concrete, for which the period shall be at least the first three days after placement. Horizontal surfaces shall be kept covered, and intermittent, localized drying will not be permitted.

C. Walls that will be exposed on one side with either fluid or earth backfill on the opposite side shall be continuously wet cured for a minimum of five days. Use of a curing compound will not be acceptable for applications of this type.

D. The Contractor shall use one of the following methods to insure that the concrete remains in a moist condition for the minimum period stated above.

1. Ponding or continuous fogging or sprinkling.

2. Application of mats or fabric kept continuously wet.

3. Continuous application of steam (under 150°F).

4. Application of sheet materials conforming to ASTM C171.

5. If approved by the Engineer, application of a curing compound in accordance with Article 3.04.

E. The Contractor shall keep absorbent wood forms wet until they are removed. After form removal, the concrete shall be cured by one of the methods in paragraph D.

F. Any of the curing procedures used in Paragraph 3.01-D may be replaced by one of the other curing procedures listed in Paragraph 3.01-D after the concrete is one-day old. However, the concrete surface shall not be permitted to become dry at any time.

3.02 CURING CONCRETE UNDER COLD WEATHER CONDITIONS

A. Suitable means shall be provided for a minimum of 72 hours after placing concrete to maintain it at or above the minimum as placed temperatures specified in Section 03300, Cast-In-Place Concrete, for concrete work in cold weather. During the 72-hour period, the concrete surface shall not be exposed to air more than 20°F above the minimum as placed temperatures.

B. Stripping time for forms and supports shall be increased as necessary to allow for retardation in concrete strength caused by colder temperatures. This retardation is magnified when using concrete made with blended cements or containing fly ash or ground granulated blast furnace slag. Therefore, curing times and stripping times shall be further increased as necessary when using these types of concrete.

C. The methods of protecting the concrete shall be approved by the Engineer and shall be such as will prevent local drying. Equipment and materials approved for this purpose shall be on the site in sufficient quantity before the work begins. The Contractor shall assist the Engineer by providing holes in the forms and the concrete in which thermometers can be placed to determine the adequacy of heating and protection. All such thermometers shall be furnished by the Contractor in quantity and type which the Engineer directs.

D. Curing procedures during cold weather conditions shall conform to the requirements of ACI 306.

3.03 CURING CONCRETE UNDER HOT WEATHER CONDITIONS

A. When air temperatures exceed 85°F, the Contractor shall take extra care in placing and finishing techniques to avoid formation of cold joints and plastic shrinkage cracking. If ordered by the Engineer, temporary sun shades and/or windbreakers shall be erected to guard against such developments, including generous use of wet burlap coverings and fog sprays to prevent drying out of the exposed concrete surfaces.

B. Immediately after screeding, horizontal surfaces shall receive an application of evaporation reducer. Apply in accordance with manufacturer's instructions. Final finish work shall begin as soon as the mix has stiffened sufficiently to support the workmen.

C. Curing and protection of the concrete shall begin immediately after completion of the finishing operation. Continuous moist-curing consisting of method 1 or 2 listed in paragraph 3.01D is mandatory for at least the first 24 hours. Method 2 may be used only if the finished surface is not marred or blemished during contact with the coverings.

D. At the end of the initial 24-hour period, curing and protection of the concrete shall continue for at least four (4) additional days using one of the methods listed in paragraph 3.01D.

E. Curing procedures during hot weather conditions shall conform to the requirements of ACI 305.

3.04 USE OF CURING COMPOUND

A. Curing compound shall be used only where specifically approved by the Engineer. Curing compound shall never be used for curing exposed walls with fluid or earth backfill on the opposite side. A continuous wet cure for a minimum of five days is required for these applications. Curing compound shall not be used on surfaces exposed to water in potable water storage tanks and treatment plants unless curing compound is certified in accordance with ANSI/NSF Standard 61.

B. When permitted, the curing compound shall maintain the concrete in a moist condition for the required time period, and the subsequent appearance of the concrete surface shall not be affected.

C. The compound shall be applied in accordance with the manufacturer's recommendations after water sheen has disappeared from the concrete surface and after finishing operations. Maximum coverage for the curing and sealing compound shall be 300 square feet per gallon for trowel finishes and 200 square feet per gallon for floated or broom surfaces. Maximum coverage for compounds placed where subsequent finishes will be applied shall be 200 square feet per gallon. For rough surfaces, apply in two directions at right angles to each other.

3.05 EARLY TERMINATION OF CURING

A. Moisture retention measures may be terminated earlier than the specified times only when at least one of the following conditions is met:

1. The strength of the concrete reaches 85 percent of the specified 28-day compressive strength in laboratory-cured cylinders representative of the concrete in place, and the temperature of the in-place concrete has been constantly maintained at 50 degrees Fahrenheit or higher.

2. The strength of concrete reaches the specified 28-day compressive strength as determined by accepted nondestructive methods or laboratory-cured cylinder test results.

- END OF SECTION -

SECTION 03400

PRECAST CONCRETE

PART 1 -- GENERAL

1.01 REQUIREMENTS

A. The Contractor shall construct all precast concrete items as required in the Contract Documents, including all appurtenances necessary to make a complete installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 - Utility Structures

B. Section 03200 - Reinforcing Steel

C. Section 03300 - Cast-in-Place Concrete

D. Section 03350 - Concrete Finishes

E. Section 03370 - Concrete Curing

F. Section 03600 - Grout

G. Section 05010 - Metal Materials

H. Section 05035 - Galvanizing

I. Section 05050 - Metal Fastening

J. Section 05830 - Bearing Devices

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the end of the Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. ACI 318-Building Code Requirements for Structural Concrete

3. PCI Standard MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products

4. PCI Design Handbook

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1.04 SUBMITTALS

A. The Contractor shall submit the following for review in accordance with Section 01300, Submittals.

1. Shop drawings for all precast concrete items showing all dimensions, locations, and type of lifting inserts, and details of reinforcement and joints.

2. A list of the design criteria used by the manufacturer for all manufactured, precast items.

3. Design calculations, showing at least the design loads and stresses on the item, shall be submitted. Calculations shall be signed and sealed by a Professional Engineer registered in the State of Kentucky.

4. Certified reports for all lifting inserts, indicating allowable design loads.

5. Information on lifting and erection procedures.

1.05 QUALITY ASSURANCE

A. All manufactured precast concrete units shall be produced by an experienced manufacturer regularly engaged in the production of such items. All manufactured precast concrete and site-cast units shall be free of defects, spalls, and cracks. Care shall be taken in the mixing of materials, casting, curing and shipping to avoid any of the above. The Engineer may elect to examine the units at the casting yard or upon arrival of the same at the site. The Engineer shall have the option of rejecting any or all of the precast work if it does not meet with the requirements specified herein or on the Drawings. All rejected work shall be replaced at no additional cost to the Owner.

B. Manufacturer Qualifications

The precast concrete manufacturing plant shall be certified by the Prestressed Concrete Institute, Plant Certification Program, prior to the start of production. Certification is only required for plants providing prestressed structural members such as hollow core planks, double-T members, etc.

C. Plant production and engineering must be under direct supervision and control of an Engineer who possesses a minimum of five years experience in precast concrete work.

PART 2 -- PRODUCTS

2.01 CONCRETE

A. Concrete materials including portland cement, aggregates, water, and admixtures shall conform to Section 03300, Cast-in-Place Concrete.

B. For prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 5,000 psi unless otherwise specified. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi unless otherwise specified.

C. For non-prestressed concrete items, minimum compressive strength of concrete at 28 days shall be 4,000 psi unless otherwise specified.

2.02 GROUT

A. Grout for joints between panels shall be a cement grout in conformance with Section 03600, Grout.

B. Minimum compressive strength of grout at 7 days shall be 3,000 psi.

2.03 REINFORCING STEEL

A. Reinforcing steel used for precast concrete construction shall conform to Section 03200, Reinforcing Steel.

2.04 PRESTRESSING STRANDS

A. Prestressing strands shall be 7-wire, stress-relieved, high-strength strands Grade 250K or 270K.

2.05 STEEL INSERTS

A. Steel inserts shall be in accordance with Section 05010, Metal Materials.

B. All steel inserts protruding from or occurring at the surface of precast units shall be galvanized in accordance with Section 05035, Galvanizing.

2.06 WELDING

A. Welding shall conform to Section 05050, Metal Fastening.

2.07 BEARING PADS

A. Neoprene bearing pads shall conform to Section 05830, Bearing Devices and Anchors.

B. Plastic bearing pads shall be multi-monomer plastic strips which are non-leaching and support construction loads with no visible overall expansion, manufactured specifically for the purpose of bearing precast concrete.

## PART 3 -- EXECUTION

3.01 FABRICATION AND CASTING

A. All precast members shall be fabricated and cast to the shapes, dimensions and lengths shown on the Drawings and in compliance with PCI MNL-116. Precast members shall be straight, true and free from dimensional distortions, except for camber and tolerances permitted later in this clause. All integral appurtenances, reinforcing, openings, etc., shall be accurately located and secured in position with the form work system. Form materials shall be steel and the systems free from leakage during the casting operation.

B. All cover of reinforcing shall be the same as detailed on the Drawings.

C. Because of the critical nature of the bond development length in prestressed concrete panel construction, if the transfer of stress is by burning of the fully tensioned strands at the ends of the member, each strand shall first be burned at the ends of the bed and then at each end of each member before proceeding to the next strand in the burning pattern.

D. The Contractor shall coordinate the communication of all necessary information concerning openings, sleeves, or inserts to the manufacturer of the precast members.

E. Concrete shall be finished in accordance with Section 03350, Concrete Finishes. Grout all recesses due to cut tendons which will not otherwise be grouted during erection.

F. Curing of precast members shall be in accordance with Section 03370, Concrete Curing. Use of a membrane curing compound will not be allowed.

G. The manufacturer shall provide lifting inserts or other approved means of lifting members.

3.02 HANDLING, TRANSPORTING AND STORING

A. Precast members shall not be transported away from the casting yard until the concrete has reached the minimum required 28 day compressive strength and a period of at least 5 days has elapsed since casting, unless otherwise permitted by the Engineer.

B. No precast member shall be transported from the plant to the job site prior to approval of that member by the plant inspector. This approval will be stamped on the member by the plant inspector.

C. During handling, transporting, and storing, precast concrete members shall be lifted and supported only at the lifting or supporting points as indicated on the shop drawings.

D. All precast members shall be stored on solid, unyielding, storage blocks in a manner to prevent torsion, objectionable bending, and contact with the ground.

E. Precast concrete members shall not be used as storage areas for other materials or equipment.

F. Precast members damaged while being handled or transported will be rejected or shall be repaired in a manner approved by the Engineer.

3.03 ERECTION

A. Erection shall be carried out by the manufacturer or under his supervision using labor, equipment, tools and materials required for proper execution of the work.

B. Contractor shall prepare all bearing surfaces to a true and level line prior to erection. All supports of the precast members shall be accurately located and of required size and bearing materials.

C. Installation of the precast members shall be made by leveling the top surface of the assembled units keeping the units tight and at right angles to the bearing surface.

D. Connections which require welding shall be properly made in accordance with Section 05050, Metal Fastening.

E. Grouting between adjacent precast members and along the edges of the assembled precast members shall be accomplished as indicated on the drawings, care being taken to solidly pack such spaces and to prevent leakage or droppings of grout through the assembled precast members. Any grout which seeps through the precast members shall be removed before it hardens.

F. In no case shall concentrated construction loads, or construction loads exceeding the design loads, be placed on the precast members. In no case shall loads be placed on the precast members prior to the welding operations associated with erection, and prior to placing of topping (if required).

G. No Contractor, Subcontractor or any of his employees shall arbitrarily cut, drill, punch or otherwise tamper with the precast members.

H. Precast members damaged while being erected will be rejected or shall be repaired in a manner approved by the Engineer.

- END OF SECTION -

SECTION 03415

PRECAST PRESTRESSED CONCRETE
HOLLOW CORE PLANKS

## PART 1 -- GENERAL

### 1.01 REQUIREMENTS

A. The Contractor shall furnish all materials, labor, equipment, tools, etc., required for the design, fabrication, delivery and erection of precast, prestressed concrete hollow core planks in accordance with the Drawings and as specified herein.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03400 – Precast Concrete

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ACI 423 - Recommendations for Concrete Members Prestressed with Unbonded Tendons

2. PCI Design Handbook

### 1.04 SUBMITTALS

A. Submittals shall comply with Section 03400, Precast Concrete.

### 1.05 QUALITY ASSURANCE

A. Quality assurance shall comply with Section 03400, Precast Concrete.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

A. Materials shall comply with Section 03400, Precast Concrete, except as stated below.

B. Minimum compressive strength of concrete at transfer of prestressing force shall be 3,500 psi.

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PART 3 -- EXECUTION

3.01 DESIGN CRITERIA

A. All units shall be designed in accordance with the applicable provisions of ACI 318 and PCI Design Handbook, prestressed to sustain the superimposed dead and live loads indicated herein and on the Drawings. Design and subsequent fabrication shall provide for a camber in each unit to eliminate total dead load deflection.

B. Superimposed Roof Loads

1. Dead Loads - Uniform load shall be that resulting from weight of member and weights of insulation material, built-up roofing, ballast, and lightweight concrete, as shown on the Drawings. Concentrated load at crane rail hanger-support shall be that resulting from contributing weight of crane rail and its support-assembly.

2. Live Loads - Uniform live load shall be 30 psf unless noted otherwise on the Drawings. Concentrated hoist loads shall consist of the rated capacity plus 33% impact loading and shall occur where crane rails are shown on the Drawings.

3. Other applicable loads per the 2012 International Building Code with 2013 Kentucky Amendments as indicated on the Drawings.

3.02 FABRICATION AND CASTING

A. All hollow core planks shall comply with Section 03400, Precast Concrete.

B. Hollow core plank dimensions shall comply with PCI Design Handbook and as indicated on the Drawings.

C. Curing of hollow core planks shall be equivalent to three days moist curing at 70°F.

D. Unless otherwise noted on the Drawings, permitted dimensional tolerances are as follows:

| | | |
|---|---|---|
| 1. | Length | ±1/2" |
| 2. | Width | ±1/4" Max. |
| 3. | Depth | ±1/4" Max. |
| 4. | Differential Camber Between Adjacent Units | 1/4" Max. |
| 5. | Horizontal Alignment | ±1/8" per 10' ±1/2" Max. |
| 6. | Location of openings, blockouts, anchors, plates and inserts | ±1/2" Max. |
| 7. | Square Ends | ±1/8" per 12" of Height |

3.03 HANDLING, TRANSPORTING, AND STORING

A. Handling, transporting, and storing shall comply with Section 03400, Precast Concrete.

3.04 ERECTION

A. Erection shall comply with Section 03400, Precast Concrete.

B. All hollow core planks shall bear on bearing pads at each end.

1. All hollow core planks shall bear on plastic or neoprene bearing pads at each end in accordance with Section 03400, Precast Concrete. Pads shall be the size shown on the Contract Drawings.

2. Where neoprene pads are shown on the Drawings, hollow core planks shall bear on elastomeric bearing pads at each end in accordance with Section 05830, Bearing Devices. Pads shall be the size shown on the Contract Drawings and shall be adhered to the supporting concrete surface below with an approved adhesive.

C. The top of all hollow core planks which receive concrete topping shall be cleaned of all contaminants and thoroughly wetted just prior to placing the topping.

- END OF SECTION -

SECTION 03600

GROUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all grout used in concrete work and as bearing surfaces for base plates, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Requirements of related work are included in Division 1 and Division 2 of these Specifications.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

| | | |
|---|---|---|
| 1. | CRD-C 621 | Corps of Engineers Specification for Non-shrink Grout |
| 2. | ASTM C 109 | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch or 50 mm cube Specimens) |
| 3. | ASTM C 531 | Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacings |
| 4. | ASTM C 579 | Test Method for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacings |
| 5. | ASTM C 827 | Standard Test Method for Early Volume Change of Cementitious Mixtures |
| 6. | ASTM C 144 | Standard Specification for Aggregate for Masonry Mortar |
| 7. | ASTM C 1107 | Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink) |

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Certified test results verifying the compressive strength and shrinkage and expansion requirements specified herein.

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2. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement and appropriate uses for each type of grout used in the work.

1.05 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken during construction from the first placement of each type of grout and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. The specimens will be made by the Engineer or its representative.

a. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days, 28 days and any additional time period as appropriate.

b. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C 579, Method B, at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at seven days and any other time period as appropriate.

2. The cost of all laboratory tests on grout will be borne by the Owner, but the Contractor shall assist the Engineer in obtaining specimens for testing. The Contractor shall be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens, at no additional cost to the Owner.

3. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White portland cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.

2. The minimum compressive strength at 28 days shall be 4000 psi.

3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.

4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "Sikagrout 212" by Sika Corporation, Conspec 100 Non-Shrink Non-Metallic Grout by Conspec, Masterflow 555 Grout by BASF Construction Chemicals.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452 Series" by Euclid Chemical, Concresive 1090 by BASF Construction Chemicals.

2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

D. Epoxy Base Plate Grout

1. Epoxy base plate grout shall be Sikadur 42, Grout-Pak by Sika Corporation, or Masterflow MP by BASF Construction Chemicals.

2.02 CURING MATERIALS

A. Curing materials shall be as specified in Section 03370, Concrete Curing for cement grout and as recommended by the manufacturer for prepackaged grouts.

## PART 3 -- EXECUTION

3.01 GENERAL

A. The different types of grout shall be used for the applications stated below unless noted otherwise in the Contract Documents. Where grout is called for in the Contract Documents which does not fall under any of the applications stated below, non-shrink grout shall be used unless another type is specifically referenced.

1. Cement grout shall be used for grout toppings and for patching of fresh concrete.

2. Non-shrink grout shall be used for grouting beneath base plates of structural metal framing.

3. Epoxy grout shall be used for bonding new concrete to hardened concrete.

4. Epoxy base plate grout shall be used for precision seating of base plates including base plates for all equipment such as engines, mixers, pumps, vibratory and heavy impact machinery, etc.

B. New concrete surfaces to receive cement grout shall be as specified in Section 03350, Concrete Finishes, and shall be cleaned of all dirt, grease and oil-like films. Existing concrete surfaces shall likewise be cleaned of all similar contamination and debris, including chipping or roughening the surface if a laitance or poor concrete is evident. The finish of the grout surface shall match that of the adjacent concrete. Curing and protection of cement grout shall be as specified in Section 03370, Concrete Curing.

C. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

D. The Contractor, through the manufacturer of a non-shrink grout and epoxy grout, shall provide on-site technical assistance upon request, at no additional cost to the Owner.

3.02 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow.

3.03 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

3.04 GROUT INSTALLATION

A. Grout shall be placed quickly and continuously, shall completely fill the space to be grouted and be thoroughly compacted and free of air pockets. The grout may be poured in place, pressure grouted by gravity, or pumped. The use of pneumatic pressure or dry-packed grouting requires approval of the Engineer. For grouting beneath base plates, grout shall be poured from one side only and thence flow across to the open side to avoid air-entrapment.

- END OF SECTION -

SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Mortar for unit masonry work.

2. Grout for grouting masonry.

3. Mortar for pointing and touchup.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04150 - Masonry Accessories

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, the Work shall conform to the applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | ASTM C91 | Standard Specification for Masonry Cement |
| 2. | ASTM C144 | Standard Specification for Aggregate for Masonry Mortar |
| 3. | ASTM C150 | Standard Specification for Portland Cement |
| 4. | ASTM C207 | Standard Specification for Hydrated Lime for Masonry Purposes |
| 5. | ASTM C270 | Standard Specification for Mortar for Unit Masonry |
| 6. | ASTM C476 | Standard Specification for Grout for Masonry |
| 7. | ASTM C979 | Pigments for Integrally Colored Concrete |
| 8. | ASTM C1019 | Standard Methods of Sampling and Testing Grout |
| 9. | ACI 530.1/ASCE 6 | Specification for Masonry Structures |

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1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's data and mixing instructions for each product.

2. Certificate of compliance with these specifications for each material specified below.

3. Test reports.

4. Samples of colored masonry mortar.

1.05 DELIVERY AND STORAGE

A. Deliver materials in manufacturer's original containers, bearing labels indicating product and manufacturer's name.

B. Store cementitious materials in waterproof locations to prevent damage by elements. Reject containers showing evidence of damage.

C. Store aggregates in separate bins to prevent intrusion of foreign particles. Do not use bottom 6 inches of sand or other aggregate stored in contact with the ground.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. LaFarge, Reston, VA

2. Lehigh Cement Company, Allentown, PA

3. Holcim, Inc., Dundee, MI

2.02 MATERIALS

A. Mortar and Grout Materials

1. Portland Cement: ASTM C-150, Type I above grade and Type II below grade.

2. Hydrated lime: ASTM C-207, Type "S".

3. Sand: Clean, coarse, free of loam, salt, organic and foreign matter and conforming to ASTM C-144.

4. Coarse and fine aggregates for grout: ASTM C-404.

5. Masonry Cement: ASTM C 91, Type S and meet the following criteria:

a. Prepackaged masonry cement shall contain Portland Cement, hydrated lime and plasticizing admixtures or hydraulic hydrated lime. Masonry cements which contain other materials, including ground limestone, ground slag, or other cementitious and non-cementitious materials, are not acceptable.

6. Water - clean, fresh, potable and free from injurious amounts of oil, acids, alkalies, salts, organic matter or other deleterious substances.

B. Admixtures

1. Do not use calcium chloride.

2. Provide water repellant admixture in mortar used for architectural concrete masonry units. Admixture shall be compatible with ACMU water repellant admixture.

3. Do not use admixtures, without written approval of Engineer.

C. Mortar pigment

1. Natural or synthetic iron oxide and chromium oxides meeting the requirements of ASTM C979.

2. Pigment shall not exceed 10% of the weight of Portland cement. Carbon black shall not exceed 2% of Portland cement.

3. Color shall be selected by the Owner from the manufacturer's full range of colors.

2.03 GROUT AND MORTAR MIXES

A. Masonry mortar shall be Type "S" according to ASTM C-270. Proportions for masonry mortar shall be one of the following:

1. Proportions by volume: 1 part Portland cement to 1/4 - 1/2 parts hydrated lime, and aggregate volume of not less than 2-1/4 or more than 3 times the sum of the volumes of cement and lime.

2. Proportions by volume: 1/2 part Portland cement to 1 part masonry cement, and aggregate volume of not less than 1-1/4 or more than 3 times the sum of the volumes of cement and lime.

B. Proportions for pointing mortar.

1. Proportions by volume: 1 part Portland cement to 1/4 part hydrated lime and 2 parts extra fine sand.

C. Masonry Grout shall conform to the requirements of ASTM C 476 and ACI 530.1/ASCE 6, strength of grout, tested in accordance with ASTM C 1019 shall be equal to f'm as specified in Section 04200, but not less than 2,000 psi.

1. Test grout for every 5,000 square feet of masonry, with a minimum of one test per structure.

PART 3 -- EXECUTION

3.01 FIELD MORTAR MIXING

A. Mixing shall be by mechanically operated batch mixer. Entirely discharge before recharging. Mix sand, lime, cement and admixtures dry for two (2) minutes minimum, add water and mix for three (3) minutes minimum. Control batching procedures by measuring materials by volume. Measurement by shovel count shall not be permitted. Mix mortar with less water than the maximum amount, consistent with workability, to provide near maximum tensile bond strength. Mix only quantity that can be used before initial set, or within the first one-half hour.

B. Mixers, wheel barrows, mortar boards, etc., shall be kept clean.

C. Retempering of mortar will not be permitted and mortar allowed to stand more than one (1) hour shall not be used.

3.02 INSTALLATION

A. Install mortar and grout in accordance with ACI 530.1/ASCE 6.

3.03 REPOINTING MORTAR

A. Prehydrate the mortar by mixing ingredients together dry, and then add only enough water to make a damp, stiff mix that will retain its form when pressed into a ball. After one to two hours, add water to bring it to the proper consistency.

- END OF SECTION -

SECTION 04150

MASONRY ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Metal joint reinforcement for masonry.

2. Accessories for masonry construction.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04100 - Mortar and Masonry Grout

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications, Work shall conform to the applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | ASTM A82 | Standard Specification for Steel Wire, Plain, for Concrete Reinforcement |
| 2. | ASTM A153 | Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware |
| 3. | ASTM A 951 | Standard Specification for Steel Wire Masonry Joint Reinforcement |
| 4. | ASTM D1056 | Standard Specification for Flexible Cellular Materials - Sponge or Extruded Rubber |
| 5. | ACI 530.1/ASCE 6 | Specifications for Masonry Structures |

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Provide manufacturer's complete product data.

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2. Provide manufacturer's certification attesting compliance of material and source of each material specified below.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS FOR MASONRY REINFORCEMENT

A. Subject to compliance with the Specifications, provide products manufactured by the following:

1. AA Wire Products, Company, Chicago, IL

2. Dur-O-Wal, Inc., Arlington Heights, IL

3. Heckmann Building Products, Inc., Chicago, IL.

4. Holman and Barnard, Inc., Hauppauge, NY.

2.02 MATERIALS

A. Multi Wythe Joint Reinforcement

Steel ladder type reinforcement conforming to ASTM A 951 with adjustable pintel and eye assembly; 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A 82, with widths 2-inches less than nominal wall thickness. Provide seismic clip with 9 gauge continuous wire.

B. Single Wythe Joint Reinforcement

Steel ladder type reinforcement conforming to ASTM A 951 with 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A 82, with widths 2-inches less than nominal wall thickness.

C. Anchors: Cast into concrete or weld to steel.

1. Dovetail Slot shall be 1 inch back by 1 inch deep by 5/8 inch throat, 22 gauge, foam filled.

2. Dovetail Anchor - accessory for anchoring triangular flexible tie to dovetail slot, shall be 12 gage by 1 inch wide 1/2 inch long dovetail section.

3. Wire/Strap Anchor - 1/4 inch wire or 12 gauge x 3/4 inch x length required, welded or mechanically attached to back up structure.

D. Ties

1. Triangular Flexible Tie: 3/16 inch wire, sized to suit application.

2. Adjustable Tie: Pintel and eye full tie; properly sized for application, 3/16 inch cold drawn steel.

E. Seismic Clip and Continuous Wire

1. Seismic clip shall be impact resistant PVC with retaining ridges to accept continuous wire.

2. Continuous wire shall be 9 gauge galvanized steel.

F. Top of Wall Anchor

1. Top of wall anchor shall be a 3/8” diameter rod welded to a 3/16” plate with two anchor holes. Provide a plastic tube to allow vertical deflection.

G. Finish

1. Reinforcements, anchorages and ties shall be hot dipped galvanized, Class B-2, after fabrication in accordance with ASTM A153.

2.03 ACCESSORIES

A. Expansion and Joint Filler Material

1. Closed cell neoprene material conforming to ASTM D 1056, with a minimum compressibility of 50%. Horizontal joint filler shall be 1/4 inch thick. Expansion joints shall be a minimum 3/8" thick.

B. Weep and Vent Holes

1. Open head joints for brick and half-head joints for concrete masonry veneer.

C. Control Joint

1. Wide flange rapid preformed neoprene or PVC gasket.

D. Hardware Cloth

1. Waterproof paper backed with 1/2 inch hardware cloth.

E. Through Wall Flashing

1. Self-sealing, fully adhering composite flashing consisting of 32 mil rubberized asphalt bonded to a 8 mil cross laminated polyethylene film to produce an overall 40 mil thickness.

2. Provide Perm-A-Barrier Wall Flashing by W.R. Grace, Flash-Bond by Wire-Bond or Poly-Barrier Wall Flashing by Polytite Manufacturing Corporation.

F. Cavity Drainage Mat

1. CavClear Masonry Mat by CavClear, Hudson WI. Or approved equal. Description: Fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100% recycled polymer with PVC binder. Thickness as noted on drawings.

PART 3 -- EXECUTION

3.01 REINFORCEMENT AND ANCHORAGE

A. In masonry wall panels, place horizontal joint reinforcement at a vertical spacing of 16 inches on center, unless otherwise noted.

B. Lap side rods at each end joint a minimum of 6 inches.

C. Install prefabricated corner and tee assemblies at each wall corner and intersection.

D. Mitre and butt end joints are prohibited.

E. Place horizontal joint reinforcement in approximate center of out-to-out wall assembly and assuring a 5/8 inch, minimum, mortar coverage on exterior face and 1/2 inch on interior face.

F. Adjustable anchor assemblies may be offset no more than that which is stated in manufacturer's published instructions. Pintles may be installed either up or down.

G. Install horizontal joint reinforcement continuous, terminating only at vertical control joints.

H. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend 24 inches minimum each side of opening.

I. Place joint reinforcement continuous and at 8 inches on center vertically above roof.

J. Place reinforcing bars supported and secured against displacement. Maintain position with ½ inch to true dimension.

K. Coordinate and verify that dowels and anchorages embedded in concrete and attached to structural steel members are properly placed.

L. Provide wall ties for masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place at maximum 8 inches on center each way around perimeter of openings, within 12 inches of openings.

M. Masonry adjacent to steel and concrete columns to be attached to the column with masonry anchors at 16 inches on center. Anchors to be attached to each face of the column which is adjacent to a masonry wall, unless otherwise noted.

3.02 DOVETAIL SLOTS AND ANCHORS

A. Provide dovetail slots to concrete contractor for placement into the concrete construction. Dovetail slots shall be placed vertically and spaced 16 inches on center horizontally.

B. Remove slot filler after forms are removed.

C. Hook dovetail anchor into slots and set in masonry joints at 16 inches on center.

3.03 BENDING, CUTTING AND SPLICING REINFORCEMENT

A. Make bends and splices in reinforcement only where indicated, or prior-approval by Engineer. Bend reinforcement only when cold, and prior to any placement in construction, forming around a steel pin of diameter at least 6 times the reinforcement size. Cut bars only by approved sawing, shearing or welding methods. Make ends of reinforcement straight, square, clean and free of defects before splicing. Do not heat or weld bends and splices at points of maximum stress. Clip and bend any tie wires as required to direct the ends away from external surfaces of masonry walls.

B. Where welding is necessary, provide materials and perform welding in accordance with AWS requirements.

C. All lap splices to be 48 bar diameters, unless otherwise noted.

3.04 THROUGH WALL FLASHING

A. Clean areas to receive flashing. Surface shall be free of voids, spalled areas, or sharp protrusions. Concrete surfaces shall be cured a minimum of 7 days.

B. Apply Primer as recommended by manufacturer.

C. Apply flashing in strict accordance with manufacturer's instructions and recommendations. Sidelaps shall be a minimum of 2½ inches. End laps shall have a 6" minimum lap. Provide end dams at ends of lintels and other interruptions.

D. Seal flashing where vertical reinforcing penetrates flashing with a mastic approved for use by manufacturer.

3.05 CAVITY DRAINAGE MAT

A. Install cavity drainage mat in air-space between insulation and masonry veneer construction full height of cavity.

B. Cavity drainage mat shall be temporarily fastened in accordance with manufacturer’s instructions.

- END OF SECTION -

SECTION 04200

UNIT MASONRY

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified work.

1. Principal items of work include:

a. Exterior masonry wall construction.

b. Interior masonry wall construction.

c. Installation of masonry reinforcement and accessories.

d. Masonry unit lintels.

e. Installing dampproofing, insulation, flashing and work required to be built into masonry work.

f. Building into masonry work all anchors, inserts, hangers and the like provided under other Sections.

g. Pointing and cleaning of exposed masonry surfaces.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04100 – Mortar and Masonry Grout

B. Section 04150 – Masonry Accessories

C. Section 07150 – Dampproofing

D. Section 07210 – Building Insulation

E. Section 07600 – Flashing and Sheet Metal

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications the Work shall conform to the applicable requirements of the following documents:

1. ACI 530.1/ASCE 6 Specifications for Masonry Structures

a) ACI 530.1/ASCE 6, jointly published by the American Concrete Institute and the American Society of Civil Engineers, hereafter referred to as ACI

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530.1 shall be considered minimum specifications for all materials, workmanship, methods and techniques for all masonry work.

b) Obtain a copy of the above Specifications prior to beginning any work in this Section.

2. ASTM C62 Standard Specification for Building Brick

3. ASTM C90 Standard Specification for Load-Bearing Concrete Masonry Units

4. ASTM C140 Standard Methods for Sampling and Testing Concrete Masonry Units

5. ASTM C216 Standard Specification for Facing Brick

6. ASTM C744 Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units

7. ANSI A41.1 R70 Code Requirements for Masonry

1.04 TESTING

A. Tests

The Owner reserves the right to test materials for compliance with these specifications. Sampling and testing will be done in accordance with the ASTM standard, by an independent testing agency employed by the Owner. Materials that fail to meet requirements are considered defective. Subsequent tests to establish compliance (of the same or new materials) shall be paid for by the Contractor.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:

1. Samples of each material to be used showing full range of colors.

2. Manufacturer's specifications and certifications of compliance to the Specifications, including results of tests on masonry units showing such compliance, for each type of masonry. Provide handling, storage, and installation instructions along with protection instructions. Indicate by transmittal that installer has received copies of each instruction.

3. Cold and/or hot weather construction procedures in accordance with ACI 530.1/ASCE 6 sections 2.3.2.2. and 2.3.2.3.

4. Cleaning procedures and cleaner for each masonry type.

1.06 MOCK-UPS

A. Build mock-ups at the site, where directed, full thickness and approximately 4 feet x 4 feet, indicating the proposed color range, texture and workmanship for each type of masonry. Obtain Engineer's acceptance of visual qualities of the mock-up before start of masonry work. Do not alter, move or destroy mock-ups until Work is completed and removal is directed by the Engineer.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in the manufacturer's original unbroken, undamaged and unopened packaging with labels bearing the name of the manufacturer and the product. Masonry units and brick shall be factory packaged and strapped, delivered to the site and stored on skids.

B. Store and handle materials to prevent inclusion of water or foreign matter and to prevent damage of any nature.

C. Distribute materials on floor slabs to prevent overloading. Designated live loads shown for floor shall not be exceeded.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Provide special shape, type or size indicated or for application requiring a form, size or finish which cannot be produced from standard masonry units by sawing. Provide solid units where masonry unit is exposed.

B. Masonry units for fire-rated walls shall comply with Underwriter's Laboratory requirements for fire rating shown on the Drawings.

2.02 MATERIALS

A. Mortar

1. In accordance with Section 04100 - Mortar and Masonry Grout

B. Face Brick

1. ASTM C-216, Type FBS, SW. modular as manufactured and distributed by Belden Brick Company, Glen-Gery Corporation, Cherokee Sanford Group, Inc. or equal. Face brick shall be selected and approved by the Owner from samples submitted. Select color from manufacturer's red color range. Sand finished brick shall not be accepted.

2. Net area compressive strength of brick masonry units shall be a minimum of 3200 psi when tested in accordance with ASTM C67. Compressive strength of masonry (f'm) shall be a minimum of 1200 psi in accordance with ACI 530.1 when these units are used with the mortar specified in Section 04100.

C. Concrete Masonry Units

1. Provide units conforming to ACI 530.1 unless otherwise specified.

2. Provide light weight units meeting the requirements of ASTM C90 for hollow and solid load bearing CMU.

3. Manufacture units of Portland Cement, conforming to ASTM C-150 and light weight aggregate conforming to ASTM C331 and ASTM C33. Weight of unit shall not exceed 105 lb. per cu. ft. when measured in accordance with provisions of ASTM C140. Units shall be nominally 8 inches x 16 inches x thicknesses shown or as required. Masonry units shall be manufactured not less than 30 days prior to being used and stored under cover until shipment. All units shall have true, sharp edges and corners, free from cracks or other defects. Provide half special sizes and shapes as required by the Drawings or to meet job conditions.

4. Net area compressive strength of concrete masonry units shall be a minimum of 1,900 psi when tested in accordance with ASTM C140. Compressive strength of masonry (f'm) shall be a minimum of 1,500 psi in accordance with ACI 530.1 when these units are used with the mortar specified in Section 04100.

D. Concrete Masonry Lintels

Specially formed units with reinforcing bars and mortar fill provided where shown and wherever openings in masonry are indicated without structural steel or other supporting lintels.

E. Glass Block

1. Size: 8"x8"x4"

2. Color: Clear.

3. Pattern: None.

4. Acceptable Manufacturers

a. J. Weck GmbH u. Company, Arlington Heights, IL

b. Pittsburg Corning Corp., Pittsburg, PA.

## PART 3 -- EXECUTION

### 3.01 GENERAL

A. Examine areas and conditions under which masonry is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Do not wet concrete masonry units.

C. Brick having absorption rates in excess of 0.025 oz. per square inch per minute (as determined per ASTM C 67) shall be wetted sufficiently so that the rate of absorption, when brick is laid, does not exceed this amount.

D. Clean reinforcing, removing loose rust, ice or other coatings from bars, before placement.

E. Thickness of cavity and composite walls, and other masonry construction shall be the full thickness shown. Build single wythe walls to the actual size of masonry units.

F. Build chases and recesses as shown and as required for the work of other trades.

G. Build other work into masonry work as shown, fitting masonry units around other work and grouting to assure anchorage.

H. Cut masonry units with motor driven saw designed to cut masonry with clean, sharp, unchipped edges. Cut units as required to provide pattern shown or specified, and to fit adjoining work neatly.

I. Cold and hot weather construction.

1. No masonry shall be erected when ambient temperature has dropped below 45°F unless it is rising and at no time when it has dropped below 40°F. Provisions shall be made for heating and drying of materials, and the complete work shall be protected in accordance with the ACI 530.1/ASCE 6 Section 2.3.2.2. Masonry shall not be laid with ice or frost on its surfaces, and no masonry shall be laid on frozen work. Any work which freezes before the mortar has set shall be removed and replaced at the Contractor's own expense. Do not use any admixtures or antifreeze in the mortar.

2. When the temperature is above 100°F or 90°F with a wind velocity greater than 8 mph, mortar beds shall be spread no more than 4 feet ahead of masonry and masonry units shall be set within one minute of spreading mortar.

3.02 CONSTRUCTION TOLERANCES

A. Variation from plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.

B. Variation from level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.

C. Variation of Linear Building Line: For position shown on plan and related portion of columns, walls, and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

D. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".

E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.03 LAYING MASONRY WALLS

A. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs, and wherever possible at other locations.

B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.

C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below.

D. Stopping and Resuming Work: Rack back 1/2 unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, and remove loose masonry units and mortar prior to laying fresh mortar.

E. Cover top of walls at the end of each day. Protect wall from water infiltration from the top until wall is capped.

F. Built-In Work: As work progresses, build-in items specified under this and other sections of these Specifications. Fill in solidly with masonry around built-in items.

1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.

2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of hardware cloth in the joint below and rod grout into core.

3. Fill cores in hollow masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise noted.

4. Seal masonry tight around wall penetrations such as beams, joists, pipes, ducts, and conduit by cutting masonry units to fit as tightly as possible, then closing final gap all around with mortar, or joint filler and caulking as necessary.

3.04 MORTAR BEDDING AND JOINTING

A. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs with mortar in starting courses on footing or floors, and where

adjacent cells are to be reinforced or filled with grout. For starting courses where cells are not grouted, spread full mortar bed including areas under cells.

C. Maintain joint widths of 3/8", except for minor variations required to maintain bond alignment.

D. Tooling: Joints shall be tooled to a uniform concave joint. Head joints first and then the bed joints.

E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners and jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean and reset in fresh mortar.

3.05 JOINT REINFORCING

A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints not more than 16" o.c. vertically.

B. Parapets: Use continuous horizontal joint reinforcement installed in horizontal joints at 8" o.c. vertically.

C. Reinforced masonry openings greater than 12" wide, with horizontal joint reinforcing placed in 2 horizontal joints immediately above the lintel and immediately below the sill. Extend reinforcements 2'-0" beyond jambs of the opening except at control joints.

D. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

E. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures and other special conditions.

F. Intersecting Load-bearing Walls: Provide rigid steel anchors at not more than 2'-0" o.c vertically. Embed ends in mortar-filled cores.

G. Non-loadbearing Interior Partitions: Build full height of story to underside of solid floor or structure above, unless shown otherwise. Fill joint with mortar after dead load deflection of structure above approaches final position.

3.06 CAVITY WALLS

A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity, flush.

B. Tie exterior wythe to back-up wythe of masonry with horizontal joint reinforcement at 16" o.c. vertically.

C. Coordinate placement of dampproofing and insulation board with work to ensure there are no gaps or air spaces between pieces of insulation board.

D. Weep joints shall be placed in exterior wythe of cavity wall, spaced a maximum of 32" o.c. horizontally, immediately above ledges, at lintels over openings, and as shown.

3.07 CAVITY WALL INSULATION

A. Provide and install insulation as shown and as specified in Section 07210, Building Insulation.

3.08 CONTROL AND EXPANSION JOINTS

A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where shown. Where not shown provide vertical control joints in concrete masonry units at 40 feet on center maximum or as recommended by the masonry unit manufacturer. Build-in related items as the masonry work progresses.

3.09 LINTELS

A. Install galvanized steel lintels where indicated.

B. Provide masonry lintels where shown and wherever openings of more than 8" for brick size units and 1'-4" for block size units are shown without structural steel or other supporting lintels. Provide precast or poured-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

C. For hollow concrete masonry unit walls, use specially formed "U"-shaped lintel units with reinforcement bars placed as shown and filled with grout.

D. Provide minimum bearing of 8" at each jamb.

3.10 FLASHING

A. Provide flashing as shown and as specified in Section 07600, Flashing and Sheet Metal.

3.11 REINFORCED UNIT MASONRY

A. Vertical reinforcement shall be held in place by means of frames or other suitable means. Place horizontal joint reinforcement as masonry work progresses. Provide minimum clear distance between longitudinal bars equal to nominal diameter of bar. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4", except 6 gage or smaller wires may be laid in 3/8" mortar joints. Collar joints which contain both horizontal and vertical reinforcement shall have a minimum width of 1/2" larger than the diameter of the horizontal and vertical reinforcement.

B. Bar splices shall be contact lap splices. Length of splice shall be a minimum of 24" for #4 bars and 30" for #5 bars.

C. Low lift grouting shall be used when grout space is less than 2" in width. Place grout at maximum intervals of 24" in lifts of 6 to 8 inches as the work progresses. Cores to be grouted shall be clean of mortar, mortar dropping and debris. Agitate grout to assure complete filling and coverage of reinforcement. Hold grout 1-1/2 inches below to top of masonry if work is discontinued for more than an hour.

D. High lift grouting may be used when the grout space is greater than 2". Grout shall not be placed in lifts greater than 4 feet. Grout core shall be kept clean of mortar, mortar

dripping and debris. Provide cleanout holes as required for inspection and cleaning. Replace cleanout plugs after inspection and acceptance. Do not place grout until entire wall has been in place a minimum of 3 days. Hold grout 1-1/2 inches below top of masonry if work is discontinued for more than an hour.

E. Forms and shoring shall be substantial and tight to prevent leakage of mortar or grout. Brace and shore forms to maintain position and shape. Do not remove forms or shoring until masonry gains enough strength to sufficiently carry its own weight and any other loads, temporary or permanent, placed on it during construction.

3.12 PROTECTION OF WORK

A. Exposed masonry surfaces shall be protected from staining. Tops of wall shall be covered with nonstaining waterproof coverings when work is not in progress. Installed material shall be secure in high winds.

B. Protection shall be provided for all openings in the walls to prevent damage to sills, jambs, etc., from all causes. Aluminum or steel frames and other finish materials shall be protected from damage during masonry work.

3.13 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.

B. Pointing of Masonry: At the completion of the masonry work, all holes in exposed masonry shall be pointed. Defective joints shall be cut out and tuckpointed solidly with mortar. Pointing and tuckpointing shall be done with a pre-hydrated mortar. The mortar cement shall be controlled so that, after curing of the mortar, no difference in texture or color exists with that of adjacent masonry.

C. Masonry Cleaning: While laying masonry units, good workmanship and job housekeeping practices shall be used so as to minimize the need for cleaning the masonry work. Protect the base of the wall from mud splashes and mortar droppings. The technique for laying masonry shall be such that mortar does not run down the face of the wall or smear onto the face.

1. After the joints are tooled, cut off mortar failings with the trowel and brush excess mortar burrs and dust from the face of the masonry, use a bricklayer's brush made with medium soft hair.

2. Remove all large mortar particles with a hardwood scraper.

3. If, after using the above outlined techniques, additional cleaning of the walls is found necessary, allow the walls to cure one month prior to initiating further cleaning processes.

D. Clean masonry to comply with the masonry manufacturer's directions and applicable NCMA "Tek" bulletins or BIA technical notes and the following requirements.

1. Saturate the wall with clean water. The wall shall be thoroughly saturated prior to and at the time the cleaning solution is applied.

2. Clean masonry with an approved cleaning solution for each type of masonry applied with a brush, starting at the top of the wall. Approved cleaners shall be composed primarily of detergents, wetting agents, buffering agents, and a maximum of 10% muriatic acid. Do not use acids on masonry surfaces that will be damaged by use of an acid cleaner. The use of any of the above cleaning agents shall first be approved in writing by the manufacturer of the masonry being cleaned and the Engineer. The concentration, method of application of the cleaning solution, and method of scraping shall be as outlined on the container by the manufacturer.

3. High pressure water and sandblasting shall not be used for cleaning except with the recommendation of the masonry manufacturer and the written approval of the Engineer.

4. Immediately after cleaning a small area, the wall shall be rinsed thoroughly with quantities of water.

5. Protect adjacent surfaces and materials during masonry cleaning operations.

6. After the walls are cleaned, take the necessary precautions to ensure that other contractors and subcontractors do not damage or soil the walls. Mud protection around the base of walls shall be left in place until the grading work is done.

- END OF SECTION -

SECTION 04720

CAST STONE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04150 - Masonry Accessories

B. Section 04200 - Unit Masonry

C. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications the Work shall conform to the applicable requirements of the following documents:

1. ASTM C 1364 Standard Specification for Architectural Cast Stone

1.04 TESTING

A. Tests

The Owner reserves the right to test materials for compliance with these specifications. Sampling and testing will be done in accordance with the ASTM standard, by an independent testing agency employed by the Owner. Materials that fail to meet requirements are considered defective. Subsequent tests to establish compliance (of the same or new materials) shall be paid for by the Contractor.

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Manufacturer's product data.

2. Shop drawings showing details and sizes, arrangement of joints, bonding and connections, reinforcing and method of installation and anchoring.

3. Color samples.

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1.06 QUALITY ASSURANCE

A. Manufacturer shall have a minimum of five years continuous operation producing cast stone for exterior exposure to the weather.

B. Manufacturer shall be a member of the Cast Stone Institute.

1.07 DELIVERY AND STORAGE

A. Take all measures necessary to protect products against damage during delivery and storage.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Cement: Portland Type I or Type III white/or grey meeting ASTM C150.

B. Fine Aggregate: ASTM C33, carefully graded and washed natural sands or manufactured granite, quartz, or limestone sands.

C. Course Aggregates: ASTM C33, carefully graded and washed natural gavels or crushed stone such as granite, quartz limestone or other durable stone.

D. Color: ASTM C979 natural or synthetic iron oxide pigments, excluding carbon black, and guaranteed to lime-proof. Pigment shall not exceed ten percent by weight.

E. Admixtures: ASTM C494 and as approved by the Engineer.

F. Water: Potable and free of impurities.

G. Air Entrainment: ASTM C260 and as approved by the Engineer. Wet cast mixtures shall contain five to seven percent air entrainment.

2.02 PROPERTIES OF MIX DESIGN

A. Manufacturer shall be responsible for mix design which meets required strength, exposure and finish.

B. Compressive strength shall not be less than 6500 psi at 28 days.

C. Average water absorption shall not exceed six percent by weight.

2.03 REINFORCEMENT

A. Reinforcing Steel: ASTM 615, Grade 60. Reinforcing shall be galvanized and have a minimum of 2 inches of cover for bars greater that 5/8 inch diameter and 1 1/2 inch of cover for bars less than 5/8 inch diameter.

B. Design units for handling, setting, temperature and structural stresses. Minimum steel shall be equal to 1/4 of the sectional area of the panel, where the panel is greater than 12 inches.

C. Anchors: Galvanized or Stainless Steel. Sized to resist structural loads.

2.04 FINISH

A. Color shall be selected by Owner from full range of colors. The surface texture shall be fine textured similar to natural stone. No bugholes are permitted.

2.05 TOLERANCES

A. Stone dimensions: Length/360 or 1/8"

B. Setting: 1/8" maximum from adjacent unit.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Cast Stone shall be set by experienced masons, accurately and in accordance with shop drawings and Cast Stone Institute Recommendations. Set each stone in a full bed of mortar with all vertical joints completely filled except as noted. All anchors shall be firmly placed.

B. Wet units prior to setting in mortar.

C. Rake mortar back for a depth of 3/4 inch.

D. All cornices, copings, and other horizontal bands of cast stone shall be laid with unfilled head joints.

E. Joints shall be pointed to slight concave joints.

F. Install backer rod and caulk head joints of coping and similar stones.

3.02 PATCHING AND CLEANING

A. Repair chipped or damaged materials may only be repaired by mechanics approved by the Manufacturer and with Manufacturer's approved materials. Mechanics must be certified in writing prior to performing repairs.

B. Clean stones with water with no acids or other prepared cleaners without the approval of the Manufacturer.

- END OF SECTION -

SECTION 05010

METAL MATERIALS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Materials for fasteners are included in Section 05050, Metal Fastening.

B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM A36 Standard Specification for Structural Steel

B. ASTM A47 Standard Specification for Malleable Iron Castings

C. ASTM A48 Standard Specification for Gray Iron Castings

D. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

E. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

F. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes

G. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

H. ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality

I. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

J. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

K. ASTM A529 Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)

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L. ASTM A536 Standard Specification for Ductile Iron Castings

M. ASTM A570 Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality

N. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

O. ASTM A992 Standard Specification for Structural Steel Shapes

P. ASTM A666 Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications

Q. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings

R. ASTM B85 Standard Specification for Aluminum-Alloy Die Castings

S. ASTM B108 Standard Specification for Aluminum-Alloy Permanent Mold Castings

T. ASTM B138 Standard Specification for Manganese Bronze Rod, Bar, and Shapes

U. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate

V. ASTM B221 Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes

W. ASTM B308 Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded

X. ASTM B574 Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod

Y. ASTM F468 Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use

Z. ASTM F593 Standard Specification for Stainless Steel Fasteners

1.04 SUBMITTALS

A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.05 QUALITY ASSURANCE

A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 -- PRODUCTS

2.01 CARBON AND LOW ALLOY STEEL

A. Material types and ASTM designations shall be as listed below:

| | | |
|---|---|---|
| 1. | Structural Fabrications | A992, A572 Grade 50, or A36 |
| 2. | Sheet Steel | A 570 Grade C |
| 3. | Steel Angles and Plates | A36 |
| 4. | Bars and Rods | A 36 or A307 Grade A |
| 5. | Pipe - Structural Use | A53 Type E or S, Grade B |
| 6. | Tubes | A500 Grade B or A501 |
| 7. | Cold-Formed Structural Studs and Joists (18-22 gauge) | A 446 Grade C |
| | Cold-Formed Structural Studs and Joists (12-16 gauge) | A 446 Grade D |

2.02 STAINLESS STEEL

A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.

B. Material types and ASTM designations are listed below:

| | | |
|---|---|---|
| 1. | Plates and Sheets | ASTM A167 or A666 Grade A |
| 2. | Structural Shapes | ASTM A276 |
| 3. | Fasteners (Bolts, etc.) | ASTM F593 |

2.03 ALUMINUM

A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.

B. Material types and ASTM designations are listed below:

| | | |
|---|---|---|
| 1. | Structural Shapes | ASTM B308 |
| 2. | Castings | ASTM B26, B85, or B108 |
| 3. | Extruded Bars | ASTM B221 - Alloy 6061 |
| 4. | Extruded Rods, Shapes and Tubes | ASTM B221 - Alloy 6063 |
| 5. | Plates | ASTM B209 - Alloy 6061 |
| 6. | Sheets | ASTM B221 - Alloy 3003 |

C. All aluminum structural members shall conform to the requirements of Section 05140, Structural Aluminum.

D. All aluminum shall be provided with mill finish unless otherwise noted.

E. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.

F. Aluminum in contact with dissimilar materials shall be insulated with an approved dielectric.

2.04 CAST IRON

A. Material types and ASTM designations are listed below:

| | | |
|---|---|---|
| 1. | Gray | ASTM A48 Class 30B |
| 2. | Malleable | ASTM A47 |
| 3. | Ductile | ASTM A536 Grade 60-40-18 |

2.05 BRONZE

A. Material types and ASTM designations are listed below:

| | | |
|---|---|---|
| 1. | Rods, Bars and Sheets | ASTM B138 - Alloy B Soft |

2.06 HASTELLOY

A. All Hastelloy shall be Alloy C-276.

PART 3 -- EXECUTION

(NOT USED)

- END OF SECTION -

SECTION 05035

GALVANIZING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. ASTM A123 - Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip

3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

5. ASTM A780 - Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

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PART 2 -- PRODUCTS

2.01 GALVANIC COATING

A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 -- EXECUTION

3.01 FABRICATED PRODUCTS

A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.

B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.

C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.02 HARDWARE

A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153.

3.03 ASSEMBLED PRODUCTS

A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.

3.04 SHEETS

A. Iron or steel sheets which are to be galvanized shall be galvanized in accordance with ASTM A924.

3.05 REPAIR OF GALVANIZING

A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with

zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

- END OF SECTION -

SECTION 05050

METAL FASTENING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05061 – Stainless Steel

D. Section 05120 - Structural Steel

E. Section 05140 - Structural Aluminum

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. AC 193 Acceptance Criteria for Mechanical Anchors in Concrete Elements

3. AC 308 Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements

4. ACI 318 Building Code Requirements for Structural Concrete

5. ACI 355.2 Qualifications of Post-Installed Mechanical Anchors in Concrete

6. ACI 355.4 Qualifications of Post-Installed Adhesive Anchors in Concrete

7. AISC 348 The 2009 RCSC Specification for Structural Joints

8. AISC Code of Standard Practice

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| 9. | AWS D1.1 | Structural Welding Code - Steel |
| 10. | AWS D1.2 | Structural Welding Code - Aluminum |
| 11. | AWS D1.6 | Structural Welding Code – Stainless Steel |
| 12. | Aluminum Association | Specifications for Aluminum Structures |
| 13. | ASTM A572/A572M-94C | Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50 |
| 14. | ASTM A36 | Standard Specification for Carbon Structural Steel |
| 15. | ASTM A325 | Standard Specification for High-Strength Bolts for Structural Steel Joints |
| 16. | ASTM A489 | Standard Specification for Eyebolts |
| 17. | ASTM A490 | Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints |
| 18. | ASTM A563 | Standard Specifications for Carbon and Alloy Steel Nuts |
| 19. | ASTM D1785 | Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe |
| 20. | ASTM E488 | Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements |
| 21. | ASTM F436 | Standard Specification for Hardened Steel Washers |
| 22. | ASTM F467 | Standard Specification for Nonferrous Nuts for General Use |
| 23. | ASTM F593 | Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs |
| 24. | ASTM F594 | Standard Specification for Stainless Steel Nuts |
| 25. | ASTM F1554 | Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength |

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.

2. Manufacturer's installation instructions.

3. Copy of valid certification for each person who is to perform field welding.

4. Certified weld inspection reports, when required.

5. Welding procedures.

6. Installer qualifications.

7. Certification of Installer Training.

8. Inspection Reports.

9. Results of Anchor Proof Testing.

1.05 QUALITY ASSURANCE

A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.

B. Installer Qualifications: Drilled-in anchors shall be installed by an Installer with at least three years of experience performing similar installations. Installer shall be certified as an Adhesive Anchor Installer in accordance with ACI-CRSI Adhesive Anchor Installation Certification Program.

C. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the Installer on the project. Training shall consist of a review of the complete installation process for drilled-in anchors, to include but not be limited to the following:

1. Hole drilling procedure.

2. Hole preparation and cleaning technique.

3. Adhesive injection technique and dispenser training/maintenance.

4. Rebar doweling preparation and installation.

5. Proof loading/torquing.

D. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.

E. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.

F. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer and/or an acceptable independent testing laboratory, at no additional cost to the Owner.

G. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

## PART 2 -- PRODUCTS

### 2.01 ANCHOR RODS (ANCHOR BOLTS)

A. Anchor rods shall conform to ASTM F1554 Grade 36 except where stainless steel or other approved anchor rods are shown on the Drawings. Anchor rods shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.

B. Where anchor rods are used to anchor galvanized steel or are otherwise specified to be galvanized, anchor rods and nuts shall be hot-dip galvanized in accordance with ASTM F1554.

C. Where pipe sleeves around anchor rods are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

### 2.02 HIGH STRENGTH BOLTS

A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC 348 "The 2009 RCSC Specification for Structural Joints".

B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

### 2.03 STAINLESS STEEL BOLTS

A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.

B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

## 2.04 CONCRETE ANCHORS

A. General

1. Where concrete anchors are called for on the Drawings, one of the types listed below shall be used; except, where one of the types listed below is specifically called for on the Drawings, only that type shall be used. The determination of anchors equivalent to those listed below shall be on the basis of test data performed by an approved independent testing laboratory. There are two types used:

    a. Expansion anchors shall be mechanical anchors of the wedge, sleeve, drop-in or undercut type.

    b. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete. Adhesive anchors shall be two part injection type using the manufacturer's static mixing nozzle and shall be supplied as an entire system.

2. Expansion anchors shall not be used to hang items from above or in any other situations where direct tension forces are induced in anchor.

3. Unless otherwise noted, all concrete anchors which are submerged or are used in hanging items or have direct tension induced upon them, or which are subject to vibration from equipment such as pumps and generators, shall be adhesive anchors.

4. Adhesive anchors shall conform to the requirements of ACI 355.4 or alternately to AC 308. Expansion or mechanical anchors shall conform to the requirements of ACI 355.2 or alternately to AC 193. Anchors in Seismic Design Categories C through F shall conform to IBC 2012 1905.1.9 as applicable, including, seismic test requirements, in accordance with ASTM E488.

5. Fire Resistance: All anchors installed within fire resistant construction shall either be enclosed in a fire resistant envelope, be protected by approved fire-resistive materials, be used to resist wind and earthquake loads only, or anchor non-structural elements.

B. Concrete Anchor Design:

An anchor design consists of specifying anchor size, quantity, spacing, edge distance and embedment to resist all applicable loads. Where an anchor design is indicated on the Drawings, it shall be considered an engineered design and anchors shall be installed to the prescribed size, spacing, embedment depth and edge distance. If all parts of an anchor design are provided on the Drawings except embedment depth, the anchors will be considered an engineered design and the Contractor shall provide the embedment depth as indicated in Paragraph B.3 unless otherwise directed by the Engineer. Where an anchor design is not indicated by the Engineer on the Drawings, the Contractor shall provide the anchor design per the requirements listed below.

1. Structural Anchors: All concrete anchors shall be considered structural anchors if they transmit load between structural elements; transmit load between non-

structural components that make up a portion of the structure and structural elements; or transmit load between life-safety related attachments and structural elements. Examples of structural concrete anchors include but are not limited to column anchor bolts, anchors supporting non-structural walls, sprinkler piping support anchors, anchors supporting heavy, suspended piping or equipment, anchors supporting barrier rails, etc. For structural anchors, the Contractor shall submit an engineered design with signed and sealed calculations performed by an Engineer currently registered in the State of Kentucky. Structural anchors shall be of a type recommended by the anchor manufacturer for use in cracked concrete and shall be designed by the Contractor in accordance with ACI 318 Appendix D.

2. Non-Structural Anchors: All other concrete anchors may be considered non-structural concrete anchors. The Contractor shall perform an engineered design for non-structural anchors. The Engineer may request the Contractor provide anchor design details for review, but submission of a signed, sealed design is not required. Non-structural anchors shall be designed by the contractor for use in uncracked concrete.

3. Minimum anchor embedment shall be as indicated on the Drawings or determined by the Contractor's engineered design. Concrete anchors shall be embedded no less than the manufacturer's standard embedment (expansion or mechanical anchors) or to provide a minimum allowable bond strength equal to the allowable yield capacity of the rod/bolt (adhesive anchors).

C. Structural Anchors:

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be "Kwik Bolt TZ" by Hilti, Inc., "TruBolt +" by ITW Redhead, "Strong-Bolt" or "Strong-Bolt 2" by Simpson Strong-Tie Co. or "Powerstud SD-1" or "Powerstud SD-2" by Powers Fasteners.

b. Screw Anchors: Screw anchors shall be "Kwik HUS-EZ" and "KWIK HUS-EZ-I" by Hilti, Inc., "Titen HD" by Simpson Strong-Tie Co., or "Wedge-Bolt +" by Powers Fasteners. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be "HSL-3 Heavy Duty Sleeve Anchor" by Hilti, Inc. or "Power-Bolt +" by Powers Fasteners.

d. Undercut Anchors: Undercut anchors shall be "HDA Undercut Anchor" by Hilti, Inc., "Torq-Cut Undercut Anchor" by Simpson Strong-Tie Co., "Atomic + Undercut Anchor" by Powers Fasteners

2. Adhesive Anchors:

a. Adhesive anchors shall be "Epcon G5" by ITW Redhead, "HIT HY-150 Max SD" by Hilti, Inc., "SET-XP" by Simpson Strong-Tie Co., or "Powers 1000+" by Powers Fasteners.

b. Structural adhesive anchor systems shall be IBC compliant and capable of resisting short term wind and seismic loads (Seismic Design Categories A through F) as well as long term and short term sustained static loads in both cracked and uncracked concrete in all Seismic Design Categories. Structural adhesive anchor systems shall comply with the latest revision of ICC-ES Acceptance Criteria AC308, and shall have a valid ICC-ES report in accordance with the applicable building code. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

D. Non-Structural Anchors: In addition to the acceptable non-structural anchors listed below, all structural anchors listed above may also be used as non-structural anchors.

1. Mechanical Anchors:

a. Wedge Anchors: Wedge anchors shall be “Kwik Bolt 3” by Hilti, Inc. or “TruBolt” by ITW Redhead.

b. Screw Anchors: Screw anchors shall be “Kwik HUS” by Hilti, Inc., “Wedge-Bolt” by Powers Fasteners or “Large Diameter Tapcon (LDT) Anchor” by ITW Redhead. Bits specifically provided by manufacturer of chosen system shall be used for installation of anchors.

c. Sleeve Anchors: Sleeve anchors shall be “HSL Heavy Duty Sleeve Anchors” by Hilti, Inc. “Power-Bolt” by Powers Fasteners or “Dynabolt Sleeve Anchor” by ITW Redhead.

d. Drop-In Anchors: Drop-in anchors shall be “Drop-In” by Simpson Strong-Tie Co., “HDI Drop-In Anchor” by Hilti, Inc. or “Multi-Set II Drop-In Anchor” by ITW Redhead.

e. Undercut Anchors: Undercut anchors shall be “HDA Undercut Anchor” by Hilti, Inc.

2. Adhesive Anchors:

a. Adhesive anchors shall be “Epcon A7” or “Epcon C6” by ITW Redhead, “HIT HY-150 Max” by Hilti, Inc., “SET Epoxy Tie” or “AT” by Simpson Strong-Tie Co., or “Powers AC 100+ Gold” or “T308+ Epoxy” by Powers Fasteners.

b. Non-structural adhesive anchors systems shall be IBC compliant and capable of resisting short term wind and seismic (Seismic Design Categories A and B) as well as long term and short term sustained static loads in uncracked concrete

c. Non-structural adhesive anchor embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable yield capacity of the rod/bolt unless noted otherwise on the Drawings.

d. **No or equal products will be considered unless prequalified and approved by the Engineer and Owner.**

E. Concrete Anchor Rod/Bolt Materials:

1. Concrete anchors used to anchor structural steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, concrete anchors shall also be galvanized unless otherwise indicated on the Drawings.

2. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

3. Nuts, washers, and other hardware shall be of a material to match the anchors.

2.05 MASONRY ANCHORS

A. Anchors for fastening to solid or grout-filled masonry shall be adhesive anchors as specified above for concrete anchors.

B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "Epcon System A7 or C6" as manufactured by ITW Ramset/Redhead, "HIT HY-70 System" as manufactured by Hilti, Inc., "SET Epoxy-Tie" or "AT Acrylic-Tie" as manufactured by Simpson Strong-Tie Co., or "AC100+ Gold by Powers Fasteners.

C. Masonry anchors used to anchor steel shall be a threaded steel rod per manufacturer's recommendations for proposed adhesive system, but shall not have a yield strength (fy) less than 58 ksi nor an ultimate strength (fu) less than 72.5 ksi, unless noted otherwise. Where steel to be anchored is galvanized, masonry anchors shall also be galvanized.

D. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.06 WELDS

A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).

B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.

C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.07 WELDED STUD CONNECTORS

A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.08 EYEBOLTS

A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.09 HASTELLOY FASTENERS

A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

A. Antiseize lubricant shall be C5-A Anti-Seize by Loctite Corporation, Molykote P-37 Anti-Seize Paste by Dow Corning, 3M Anti-Seize by 3M, or equal.

PART 3 -- EXECUTION

3.01 MEASUREMENTS

A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.02 ANCHOR INSTALLATION

A. Anchor Rods, Concrete Anchors, and Masonry Anchors

1. Anchor rods shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template. Overhead adhesive anchors, and base plates or elements they are anchoring, shall be shored as required and securely held in place during anchor setting to prevent movement during anchor installation. Movement of anchors during curing is prohibited.

2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.

3. Concrete anchors shall not be used in place of anchor rods without Engineer's approval.

4. All stainless steel threads shall be coated with antiseize lubricant.

B. High Strength Bolts

1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". All bolted joints shall be Type N, snug-tight,

bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.

C. Concrete Anchors

1. Concrete at time of anchor installation shall be a minimum age of 21 days.

2. Concrete anchors designed by the Contractor shall be classified as structural or non-structural based on the requirements indicated above.

3. Concrete Anchor Testing:

a. At all locations where concrete anchors meet the requirements for structural anchors at least 25 percent of all concrete anchors installed shall be proof tested to the value indicated on the Drawings, with a minimum of one tested anchor per anchor group. If no test value is indicated on the Drawings but the installed anchor meets the requirements for structural anchors, the Contractor shall notify the Engineer to allow verification of whether anchor load proof testing is required.

b. Contractor shall submit a plan and schedule indicating locations of anchors to be tested, load test values and proposed anchor testing procedure (including a diagram of the testing equipment proposed for use) to the Engineer for review prior to conducting any testing. Testing of anchors shall be in accordance with ASTM E488 for the static tension test. If additional tests are required, inclusion of these tests shall be as stipulated on Contract Drawings.

c. Where Contract Documents indicate anchorage design to be the Contractor's responsibility and the anchors are considered structural per the above criteria, the Contractor shall submit a plan and schedule indicating locations of anchors to be proof tested and load test values, sealed by a Professional Engineer currently registered in the State of Kentucky. The Contractor's Engineer shall also submit documentation indicating the Contractor's testing procedures have been reviewed and the proposed procedures are acceptable. Testing procedures shall be in accordance with ASTM E488.

d. Concrete Anchors shall have no visible indications of displacement or damage during or after the proof test. Concrete cracking in the vicinity of the anchor after loading shall be considered a failure. Anchors exhibiting damage shall be removed and replaced. If more than 5 percent of tested anchors fail, then 100 percent of anchors shall be proof tested.

e. Proof testing of concrete anchors shall be performed by an independent testing laboratory hired directly by the Contractor and approved by the Engineer. The Contractor shall be responsible for costs of all testing, including additional testing required due to previously failed tests.

4. All concrete anchors shall be installed in strict conformance with the manufacturer's printed installation instructions. A representative of the manufacturer shall be on site when required by the Engineer.

5. All holes shall be drilled with a carbide bit unless otherwise recommended by the manufacturer. No cored holes shall be allowed unless specifically approved by the Engineer. If coring holes is allowed by the manufacturer and approved by the Engineer, cored holes shall be roughened in accordance with manufacturer requirements. Thoroughly clean drill holes of all debris and drill dust with compressed air followed by a wire brush prior to installation of adhesive and threaded rod/bolt unless otherwise recommended by the manufacturer. Degree of hole dampness shall be in strict accordance with manufacturer recommendations. Where depth of hole exceeds the length of the static mixing nozzle, a plastic extension hose shall be used to ensure proper adhesive injection from the back of the hole. Injection of adhesive into the hole shall utilize a piston plug to minimize the formation of air pockets. Wipe rod free from oil that may be present from shipping or handling.

D. Other Bolts

1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.

2. All stainless steel bolts shall be coated with antiseize lubricant.

3.03 WELDING

A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.04 INSPECTION

A. High strength bolting will be visually inspected in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Rejected bolts shall be either replaced or retightened as required.

B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

C. Post-installed concrete anchors shall be inspected as required by ACI 318.

3.05 CUTTING OF EMBEDDED REBAR

A. The Contractor shall not cut embedded rebar cast into structural concrete during installation of post-installed fasteners without prior approval of the Engineer.

- END OF SECTION -

SECTION 05061

STAINLESS STEEL

PART 1 -- GENERAL

1.01 SECTION INCLUDES

A. The Contractor shall furnish, install and erect the stainless steel work as shown on the Contract Drawings and specified herein.

B. Stainless steel work shall be furnished complete with all accessories, mountings and appurtenances of the type of stainless steel and finish as specified or required for a satisfactory installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 - Submittals

B. Section 05010 - Metal Materials

C. Section 05050 - Metal Fastening

D. Section 05500 - Metal Fabrications

1.03 REFERENCES

A. ASTM A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

B. ASTM A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

C. ASTM A262 - Practice for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steel.

D. ASTM A276 - Stainless and Heat-Resisting Steel Bars and Shapes.

E. ASTM A314 - Stainless and Heat-Resisting Steel Billets and Bars for Forging.

F. ASTM A380 - Practice for Cleaning and Descaling Stainless Steel Parts, Equipment and Systems.

G. ASTM A473 - Stainless and Heat-Resisting Steel Forgings.

H. ASTM A666 - Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar.

I. ASTM A774 - Stainless Steel Pipe Fittings

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J. ASTM A778 - Stainless Steel Pipe

K. ASTM F593 - Stainless Steel Bolts, Hex Cap Screws and Studs.

L. ASTM F594 - Stainless Steel Nuts.

M. ANSI/ASME B1.1 - Unified Inch Screw Thread (UN and UNR Thread Form).

1.04 TESTS

A. All stainless steel materials including stainless test welds, shall be checked for compliance with tests for susceptibility to intergranular attack. Such tests shall be Practices A, B and E of ASTM A262. Detailed procedures for the tests shall be submitted to the Engineer for approval prior to start of work. Practice A shall be used only for acceptance of materials but not for rejection of materials, and shall be used for screening material intended for testing in Practice B and Practice E. The maximum acceptable corrosion rate under Practice B shall be 0.004 inch per month, rounded off to the third decimal place. If the certified mill report indicates that such test has been satisfactory performed, the fabricator may not be required to repeat the test. Material passing Practice E shall be acceptable.

B. Sample selection for the susceptibility to intergranular attack tests shall be as follows:

1. One (1) sample per heat per heat treatment lot for plates and forgings;

2. One (1) sample per each Welding Procedure Qualification regardless of the joint design;

3. If tests indicate a reduction in corrosion resistance, welding procedure shall be adjusted or heat treatment determined as needed to restore required corrosion resistance.

4. The samples so chosen shall have received all the post-weld heat treatments identical to the finished part.

1.05 SUBMITTALS

A. The Contractor shall prepare and submit for approval shop drawings for all stainless steel fabrication in accordance with Section 01300, Submittals.

B. Submittals shall include, but not be limited to, the following:

1. Certified test reports for susceptibility to intergranular attack.

2. Affidavit of compliance with type of stainless steel shown on the Contract Drawings or specified herein.

3. Certified weld inspection reports.

4. Cleaning and handling of stainless steel in accordance with Paragraph 3.04, Cleaning and Handling.

C. Samples of finish, on each type of stainless steel to be furnished, shall be submitted to the Engineer upon request.

1.06 QUALITY ASSURANCE

A. Shop inspections may be made by the Engineer. The Contractor shall give ample notice to the Engineer prior to the beginning of any stainless steel 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 the inspectors shall be allowed free access to the necessary parts of the works.

B. Inspectors shall have the authority to reject any materials or work which does not meet the requirements of the Contract Drawings or the Specifications.

C. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship.

1.07 HANDLING, STORAGE AND DELIVERY

A. Mechanical damage (e.g., scratches and gouges) to the stainless steel material shall not be permitted and is cause for rejection. Care shall be taken in the material handling since such mechanical damage will result in the passive oxide film being "punctured" leading to a possible lower resistance to the initiation of corrosion than the surrounding chemically-passivated surface.

B. Stainless steel plates and sheets shall be stored vertically in racks and not be dragged out of the racks or over one another. Racks shall be protected to prevent iron contamination.

C. Heavy stainless steel plates shall be carefully separated and chocked with wooden blocks so that the forks of a fork-lift could be inserted between plates without mechanically damaging the surface.

D. Stainless steel plates and sheets laid out for use shall be off the floor and be divided by wooden planks to prevent surface damage and to facilitate subsequent handling.

E. Plate clamps, if used, shall be used with care as the serrated faces can dig in, indent and gouge the surface.

F. Stainless steel fabrications shall be loaded in such a manner that they may be transported and unloaded without being overstressed, deformed or otherwise damaged.

G. Stainless steel fabrications and packaged materials shall be protected from corrosion and deterioration and shall be stored in a dry area. Materials stored outdoors shall be supported above ground surfaces on wood runners and protected with approved effective and durable covers.

H. Stainless steel fabrications shall not be placed in or on a structure in a manner that might cause distortion or damage to the fabrication. The Contractor shall repair or replace damaged stainless steel fabrications or materials as directed by the Engineer.

1.08 FIELD MEASUREMENTS

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FINISHES

A. Stainless steel shall be Type 304 unless it is used for underwater service. Stainless steel for underwater service shall be Type 316. Minimum mechanical finish shall be No. 4 as stated in Table 2 unless otherwise noted on the Contract Drawings.

B. The basic mill forms (sheet, strip, plate and bar) are classified by size as shown on Table 1. Tables 2, 3 and 4 identify finishes and conditions in which sheet, bar and plate are available.

C. Tables 2, 3 and 4 show numbered finishes and conditions for sheet, bar and plate. While there are no specific designations for polished finishes on bar or plate, the sheet finish designations are used to describe the desired effect. This also applies to finishes on ornamental tubing.

D. There are three standard finishes for strip, which are broadly described by the finishing operations employed:

1. No. 1 Strip Finish

   No. 1 strip finish is approximately the same as No. 2D Sheet Finish. It varies in appearance from dull gray matte to a fairly reflective surface, depending largely on alloy composition and amount of cold reduction.

2. No. 2 Strip Finish is approximately the same as a No. 2B sheet finish. It is smoother, more reflective than No. 1, and likewise varies with alloy composition.

3. Bright annealed finish is a highly reflective finish that is retained by final annealing in a controlled atmosphere furnace.

**Table 1**

**Classification of Stainless Steel Product Form**

| Item | Description | Dimensions | | |
|---|---|---|---|---|
| | | Thickness | Width | Diameter or Size |
| Sheet | Coils and cut length:<br>Mill finishes Nos. 1, 2D and 2B<br>Polished finishes Nos. 3, 4, 6, 7 & 8 | <br>under 3/16"<br>under 3/16" | <br>24" and over<br>all widths | <br>--<br>-- |
| Strip | Cold finished, coils or cut lengths<br>Polished finishes Nos. 3, 4, 6,7 & 8 | under 3/16"<br>under 3/16" | under 24"<br>all widths | --<br>-- |
| Plate | Flat rolled or forged | 3/16" and over | over 10" | -- |
| Bar | Hot finished rounds, squares, octagons and hexagons<br>Hot finished flats<br><br>Cold finished rounds, squares, octagons and hexagons<br>Cold finished flats | --<br>1/8" to 8" incl.<br><br>--<br>1/8" to 4-1/2" | --<br>1/4" to 10" incl.<br><br>--<br>3/8" to 4-1/2" | 1/4" and over<br>--<br><br><br>over 1/8"<br>-- |
| Wire | Cold finishes only: (in coil)<br>Round, square, octagon, hexagon and flat wire | <br>under 3/16" | <br>under 3/8" | <br>-- |
| Pipe & Tubing | Several different classifications, with differing specifications, are available. | | | |
| Extrusion | Not considered “standard” shapes. Currently limited in size to approximately 6-1/2" diameter or structurals. | | | |

**Table 2**

**Standard Mechanical Sheet Finishes**

| | |
|---|---|
| **Unpolished or Rolled Finishes:**<br>No. 1 A rough dull surface which results from hot rolling to the specified thickness followed by annealing and descaling. | No. 4 A polished surface obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasives. This is a general purpose bright finish with a visible "grain" which prevents mirror reflection. |
| No. 2D A dull finish which results from cold rolling followed by annealing and descaling, and may perhaps get a final light roll pass through unpolished rolls. A 2D finish is used where appearance is of no concern. | No. 6 A dull satin finish having lower reflectivity than No. 4 finish. It is produced by Tampico brushing the No. 4 finish in a medium of abrasive and oil. It is used for architectural applications and ornamentation where a high luster is undesirable, and to contrast with brighter finishes. |
| No. 2B A bright cold-rolled finish resulting in the same manner as No. 2D finish, except that the annealed and descaled sheet receives a final light roll pass through polished rolls. This is the general purpose cold-rolled finish that can be used as is, or as a preliminary step to polishing. | No. 7 A high reflective finish that is obtained by buffing finely ground surfaces but not to the extent of completely removing the "grit" lines. It is used chiefly for architectural and ornamental purposes. |
| **Polished Finishes**:<br>No. 3 An intermediate polish surface obtained by finishing with a 100 grit abrasive. Generally used where a semi-finished polished surface is required. A No. 3 finish usually receives additional polishing during fabrication. | No. 8 The most reflective surface, which is obtained by polishing with successively finer abrasives and buffing extensively until all grit lines from preliminary grinding operations are removed. It is used for applications such as mirrors and reflectors. |

**Table 3**

**Conditions and Finishes for Bar**

| **Conditions** | **Surface Finishes[1]** |
|---|---|
| Hot worked only | (a) Scale not removed (excluding spot conditioning)<br>(b) Rough turned[2]<br>(c) Pickled or blast cleaned and pickled. |
| Annealed or otherwise heat treated. | (a) Scale not removed (excluding spot conditioning)<br>(b) Rough turned<br>(c) Pickled or blast cleaned and pickled<br>(d) Cold drawn or cold rolled<br>(e) Centerless ground<br>(f) Polished |
| Annealed and cold worked to high tensile strength[3] | (d) Cold drawn or cold rolled<br>(e) Centerless ground<br>(f) Polished |

1 Surface finishes (b), (e) and (f) are applicable to round bars only.

2 Bars of the 4xx series stainless steels which are highly hardenable, such as Types 414, 420, 420F, 431, 440A, 440B and 440C, are annealed before rough turning. Other hardenable grades, such as Types 403, 410, 416 and 416Se, may also require annealing depending on their composition and size.

3 Produced in Types 302, 303Se, 304 and 316.

**Table 4**

**Conditions and Finishes for Plate**

| Condition and Finish | Description and Remarks |
|---|---|
| Hot rolled | Scale not removed. Not heat treated. Plates not recommended for final use in this condition.[4] |
| Hot rolled, annealed or heat treated | Scale not removed. Use of plates in this condition is generally confined to heat resisting applications. Scale impairs corrosion resistance.[1] |
| Hot rolled, annealed or heat treated, blast cleaned or pickled | Condition and finish commonly preferred for corrosion resisting and most heat resisting applications. |
| Hot rolled, annealed, descaled and temper passed | Smoother finish for specialized applications. |
| Hot rolled, annealed, descaled cold rolled, annealed, descaled, optionally temper passed | Smooth finish with greater freedom from surface imperfection than the above. |
| Hot rolled, annealed or heat treated, surface cleaned and polished | Polished finishes refer to Table 2. |

[4] Surface inspection is not practicable on plates which have not been pickled or otherwise descaled.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Holes for bolts and screws shall be drilled. Fastenings shall be concealed where practicable. Joints exposed to the weather shall be formed to exclude water.

B. As far as practicable, all fabricated units shall be fitted and assembled in the shop, with all cuts and bends made to precision measurements in accordance with details shown on approved shop drawings.

C. Work shall be fabricated so that it is installed in a manner that will provide for expansion and contraction, prevent the shearing of bolts, screws and other fastenings, ensure rigidity, and provide close fitting of sections.

D. All finished and/or machined faces shall be true to line and level. Stainless steel sections shall be well formed to shape and size with sharp lines and angles; curved work shall be sprung evenly to curves.

E. All work shall be fitted together at the shop as far as possible, and delivered complete and ready for erection. Proper care shall be exercised in handling all work so as not to injure the finished surfaces.

3.02 WELDING

A. Welding shall be done in a manner that will prevent buckling and in accordance with Specification 05050 – Metal Fastening, and as modified hereinafter.

B. All welds exposed in the work shall be ground smooth and finished to match the finish of the adjacent stainless steel surfaces.

C. Select weld rods that provide weld filler metal having corrosion resistant properties as nearly identical or better than the base metal to insure preservation of the corrosion-resistant properties. Provide heat treatment at welds where testing of weld procedure indicates it is required to restore the corrosion resistance.

D. Thermal conductivity of stainless steel is about half that of other steels; and the following methods may be used to accommodate this situation:

1. Use lower weld current setting.

2. Use skip-weld techniques to minimize heat concentration.

3. Use back-up chill bars or other cooling techniques to dissipate heat.

E. Edges of the stainless steel to be welded shall be cleaned of contaminants.

3.03 FASTENERS

A. Stainless steel fasteners shall be used for joining stainless steel work.

B. Stainless steel fasteners shall be made of alloys that are equal to or more corrosion resistant than the materials they join.

3.04 CLEANING AND HANDLING

A. All stainless steel surfaces shall be precleaned, descaled, passivated and inspected before, during and after fabrication in accordance with the applicable sections of ASTM A380 and as detailed in the procedures to be submitted to the Engineer for approval prior to start of work. Degreasing and passivation of stainless steel articles shall be conducted as the last step after fabrication.

B. Measures to protect cleaned surfaces shall be taken as soon as final cleaning is completed and shall be maintained during all subsequent handling, storage and shipping.

1. The Contractor shall submit for approval specific procedures listing all the steps to be followed in detecting contamination and in descaling, cleaning, passivation and protecting of all stainless steel.

2. Area showing clear indications of contamination shall be recleaned, repassivated and reinspected.

C. At approved stages in the shop operations, contaminants such as scale, embedded iron, rust, dirts, oil, grease and any other foreign matter shall be removed from the metal, as

directed or approved by the Engineer. The adequacy of these operations shall be checked by the Engineer. Operations in the shop shall be conducted so as to avoid contamination of the stainless steel and to keep the metal surfaces free from dirt and foreign matter.

D. In order to prevent incipient corrosion during fabrication, special efforts shall be made at all times to keep all stainless steel surfaces from coming in contact with other metals.

1. Stainless steel and stainless steel welds shall be cleaned with clean sand free of iron, stainless steel wool, stainless steel brushes, or other approved means and shall be protected at all times from contamination by any materials, including carbon steel, that shall impair its resistance to corrosion.

2. Approved methods of cutting, grinding and handling shall be used to prevent contamination. If air-arc, or carbon-arc cutting is used, additional metal shall be removed by approved mechanical means so as to provide clean, weldable edges. All grinding of stainless steel shall be performed with aluminum oxide or silicon carbide grinding wheels bonded with resin or rubber. Grinding wheels used on carbon steel shall not be used on stainless steel.

3. Sand, grinding wheels, brushes and other materials used for cleaning stainless steel shall be checked periodically by the Engineer for contaminants. Cleaning aids found to contain contaminants shall not be used on the work.

3.05 INSTALLATION

A. All stainless steel fabrications shall be erected square, plumb and true, accurately fitted, adequately anchored in place, set at proper elevations and positions.

B. All inserts, anchor rods and all other miscellaneous work specified in the Detailed Specifications or shown on the Contract Drawings or required for the proper completion of the work, which are embedded in concrete, shall be properly set and securely held in position in the forms before the concrete is placed.

C. All stainless steel fabrications shall be installed in conformance with details shown on the Contract Drawings or on the approved shop drawings.

-END OF SECTION -

SECTION 05120

STRUCTURAL STEEL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. AISC - "Code of Standard Practice."

3. AISC - "Specification for Structural Steel Buildings".

4. AISC 348 - "The 2009 RCSC Specification for Structural Joints".

5. AWS - "Structural Welding Code".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

c. Detailed drawings indicating jointing, anchoring and connection details.

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1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. 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 the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

B. The erector shall be a qualified installer who participates in the AISC Certification program and is designated an AISC Certified Erector, Category ACSE.

C. The fabricator shall be a qualified fabricator who participates in the AISC Certification program and is designated an AISC Certified Plant, Category STD**.**

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural Steel

1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.

2. Structural steel for S, M, and HP shapes and channels shall conform to ASTM A572 Grade 50 unless otherwise indicated.

3. Structural steel for angles and plates shall conform to ASTM A36 unless otherwise indicated.

4. Steel pipe shall be ASTM A53, Grade B.

5. HSS shall be ASTM A500, Grade B. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.

6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.

7. Fasteners for structural steel shall be in accordance with Section 05050, Metal Fastening.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. 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.

3.02 FABRICATION

A. Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural steel members required for anchors, anchor rods, bolts, sag rods or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.

C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.

F. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. High strength bolts shall be installed in accordance with AISC 348 "The 2009 RCSC Specification for Structural Joints". Bolts specified or noted on the Drawings to be a tension or slip critical "SC" type connection shall be fully pretensioned with proper preparation of the faying surfaces. All other bolts shall be snug tightened unless otherwise noted on the Drawings.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor rods and rod holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.

4. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900, Painting and the following additional requirements.

1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.

2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.

3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

- END OF SECTION -

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all equipment, labor, materials, and services required to provide all structural aluminum work in accordance with the Contract Documents. The term "structural aluminum" shall include items as defined in the Aluminum Association "Specifications for Aluminum Structures".

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

C. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of the Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. Aluminum Association "Specifications for Aluminum Structures"

3. AWS D1.2 - "Structural Welding Code".

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Certified Mill Test Reports

2. Affidavit of Compliance with grade specified

3. Shop Drawings which include the following:

a. Layout drawings indicating all structural shapes, sizes, and dimensions.

b. Beam and column schedules.

c. Detailed drawings indicating jointing, anchoring and connection details.

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1.05 QUALITY ASSURANCE

A. Shop inspection may be required by the Owner at his own expense. 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 the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural aluminum shall comply with Section 05010, Metal Materials.

B. Fasteners for structural aluminum shall be in accordance with Section 05050, Metal Fastening.

C. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. 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.

3.02 FABRICATION

A. Fabrication shall be in accordance with the Aluminum Association "Specifications for Aluminum Structures". Fabrication shall begin only after Shop Drawing approval.

B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.

C. All holes in structural aluminum members required for anchors, anchor rods, bolts, or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.

D. All materials shall be properly worked and match-marked for field assembly.

3.03 DELIVERY, STORAGE AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

B. Structural aluminum members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.04 ERECTION

A. All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.

B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before being permanently fastened.

C. No cutting of structural aluminum members in the field will be allowed except by the written approval of the Engineer.

D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.

E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.

F. All bolted connections shall comply with Section 05050, Metal Fastening.

G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.

H. Misfits at Bolted Connections

1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.

3. Where misalignment between anchor bolts and bolt holes in aluminum members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.

2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.

3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure. Non-shrink grout shall conform to Section 03600, Grout.

4. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.05 PAINTING

A. Painting shall be performed according to Section 09900, Painting.

B. Aluminum surfaces in contact with concrete or dissimilar metals shall be thoroughly protected with two coats of epoxy paint with a minimum total thickness of 16 mils or other approved isolating material in accordance with the requirements of Section 09900 - Painting.

- END OF SECTION -

SECTION 05500

METAL FABRICATIONS

PART 1 -- GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal fabrications not specifically included in other Sections, complete and in accordance with the requirements of the Contract Documents.

B. Work shall include but may not be limited to lintels and guard posts.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

C. Section 05035 - Galvanizing

D. Certain specific items are included in other Sections of the Specifications. See the section for the specific item in question.

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. AISC - Specification for Structural Steel Buildings

3. AISI - Specifications for the Design of Cold-Formed Steel Structural Members

4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

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PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used in metal fabrications shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used in metal fabrication shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 LINTELS

A. Provide lintels as shown on the Drawings and specified herein with 8 inches minimum bearing each side unless noted otherwise.

B. All lintels shall be steel in accordance with Section 05120, Structural Steel, and shall be galvanized in accordance with Section 05035, Galvanizing, unless noted otherwise.

2.04 GUARD POSTS (BOLLARDS)

A. Guard posts shall be 6-inch diameter Schedule 40 galvanized steel pipe in accordance with ASTM A53.

B. Guard posts shall be concrete filled and crowned, as detailed in the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions

C. Metal work shall be field painted when as specified in accordance with Section 09900, Painting.

- END OF SECTION -

SECTION 05510

METAL STAIRS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all metal stairs in accordance with the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

D. Section 05120 - Structural Steel

E. Section 05140 - Structural Aluminum

F. Section 05520 - Handrails and Railings

G. Section 05531 - Gratings, Access Hatches, and Access Doors

H. Section 05550 - Stair Treads and Nosings

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. AISC Specification for Structural Steel Buildings

3. AISI Specification for the Design of Cold-Formed Steel Structural Members

4. Aluminum Association Specifications for Aluminum Structures

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300 - Submittals.

1. Complete fabrication and erection drawings of all metal work specified herein.

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2. Other submittals as required in accordance with Section 05010 - Metal Materials, and Section 05050 - Metal Fastening.

## PART 2 -- PRODUCTS

### 2.01 METAL MATERIALS

A. Metal materials used for metal stairs shall conform to Section 05010, Metal Materials, unless noted otherwise.

### 2.02 METAL FASTENING

A. All welds and fasteners used in metal stairs shall conform to Section 05050, Metal Fastening, unless noted otherwise.

### 2.03 METAL STAIRS AND LANDINGS

A. Stair stringers and structural framing of landings shall be fabricated from steel or aluminum as indicated on the Drawings.

1. Steel stairs shall be fabricated from steel in accordance with Section 05120, Structural Steel.

2. Aluminum stairs shall be fabricated from aluminum alloy 6061-T6 in accordance with Section 05140, Structural Aluminum.

B. Regardless of material of stringers, all stair treads shall be aluminum in accordance with Section 05550, Stair Treads and Nosings.

C. Where metal landings are required as indicated on the Drawings, gratings at landings shall conform to Section 05531, Gratings, Access Hatches, and Access Doors.

D. Handrails for metal stairs shall conform to Section 05520, Handrails and Railings. Contractor shall coordinate attachment of handrails to metal stairs.

E. All clips, anchors, and necessary appurtenances shall be provided for a complete and rigid installation.

F. Closure plates shall be provided for all exposed ends of stringers.

G. All exposed connections shall be welded and ground smooth, unless otherwise indicated on the Drawings.

H. Stairs and landings shall be designed to support a 100 psf live load, minimum, unless otherwise indicated on the Drawings.

## 2.04 STEEL PAN STAIRS

A. General

1. All steel stairs and landings with concrete filled steel pan risers and treads shall meet all applicable OSHA, ANSI, and NFPA codes.

2. Stair assemblies shall conform to the dimensions and arrangements shown on the Drawings.

3. Stair assemblies shall be designed to support a minimum 100 psf live load unless otherwise indicated on the Drawings.

4. Steel framing, hangers, columns, struts, clips, brackets, bearing plates, and other necessary appurtenances shall be provided for support of stairs and platforms as shown on the Drawings.

5. Exposed portions of steel pans, platforms, framing system stringers, and portions of aluminum nosings in contact with concrete, steel, or masonry shall be painted in accordance with Section 09900, Painting.

6. Concrete fill shall be 3-inches thick for platforms and 1-1/2 inches thick for pan treads.

7. Cast-in-place safety stair nosings in accordance with Section 05550, Stair Treads and Nosings, shall be provided for treads and platforms.

8. Metal pan treads, platforms, and risers shall be fabricated from 0.1084-inch thick (12 gauge minimum), galvanized structural steel sheets.

9. Risers and treads shall be supported by steel angle brackets welded to the stringers. Metal pans shall be secured to the brackets with welds.

10. Closure pieces shall be provided for ends of stringers.

B. Connections

1. All connections shall be welded unless otherwise shown on the Drawings or specified herein. All welds shall be continuous and ground smooth where exposed. Welding shall conform to Section 05050, Metal Fastening.

2. Assemblies shall be fabricated such that bolts and other fastenings do not appear on finished surfaces.

3. All joints shall be true and tight, and connections between parts shall be light-proof tight.

C. Handrails for steel pan stairs shall conform to Section 05520, Handrails and Railings. Contractor shall coordinate connection of handrails to stairs.

2.05 ALTERNATING TREAD STAIRS

A. Stairs, landings, and platforms shall be designed to carry a live load of 100 lbs. per square foot, unless noted otherwise on the Drawings.

B. The stairs shall be welded, alternating tread type stairs having a center spine and a cast integrally welded combination mounting plate and top landing, flush with the upper floor level. Handrails shall be custom formed and contoured to provide close body support and shall be welded on to the balusters which extend directly from the treads. All risers shall be equal, including the first and last risers, and treads shall have anti-skid surfaces. The stringer bottoms shall be bent and/or cut and welded to a floor plate. All exposed connections shall be welded and ground smooth.

C. Treads, floor plate castings, and landing shall be aluminum alloy AAF356F. Half treads shall be at least 9-inches wide and 10-inches deep. The central stringer shall be aluminum alloy 6063-T52, 1-3/4-inches x 4 inches x 1/8-inch box shape. Handrails shall be aluminum alloy 6061-T4. Finish shall be Aluminum Association M12C22A41.

D. The alternating tread type stairs shall be Model 68AL, as manufactured by Lapeyre Stair, Harahan, Louisiana.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in accordance with Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of metal stairs shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metal stairs shall field painted when specified in accordance with Section 09900, Painting.

- END OF SECTION -

# SECTION 05515

# LADDERS

## PART 1 -- GENERAL

1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all ladders in accordance with the requirements of the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all metalwork specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

## PART 2 -- PRODUCTS

2.01 METAL MATERIALS

A. Metal materials used for ladders shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for ladders shall conform to Section 05050, Metal Fastening, unless noted otherwise.

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2.03 LADDERS

A. Ladders shall be furnished with all mounting brackets, baseplates, fasteners, and necessary appurtenances for a complete and rigid installation.

B. All ladders shall be aluminum alloy 6061-T6 or 6063-T5, with a clear, anodized finish, Aluminum Association M12C22A41.

C. All ladders shall conform to dimensions indicated on the Drawings and shall comply with OSHA requirements.

D. Side rails shall be 1-1/2 inch diameter Schedule 80 pipe, minimum.

E. Rungs shall be serrated 3/4 inch diameter, minimum.

F. All exposed connections shall be welded and ground smooth.

G. Ladders shall be as manufactured by Thompson Fabricating Company, or equal.

2.04 FALL PREVENTION SYSTEM

A. Ladders shall be installed with a fall prevention system, unless indicated otherwise on the drawings. For all ladders with an uninterrupted length exceeding 20 ft. between landings or floors, fall prevention system is mandatory.

B. Fall prevention system shall comply with OSHA requirements.

C. Fall prevention system shall include all necessary components to provide a fully operational system, including one full body safety harness with a 310 lb. weight capacity for each fall prevention system. System shall have a fall locking device, impact attenuator, and rail system. Rail extension with dismounting system, which allows detachment from the system while not standing on the ladder, shall be provided for ladders accessed thru hatch openings. All components shall be stainless steel with a non-metallic cable guide.

D. Fall Prevention Systems shall be RTC 2000 Climb-Rite System, Research and Trading Corporation, or Saf-T-Climb Fall Prevention System, Norton by Honeywell.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

G. Fabricated items shall be shop painted when specified in accordance with Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Metalwork shall be field painted when specified in accordance with Section 09900, Painting.

- END OF SECTION -

SECTION 05520

HANDRAILS AND RAILINGS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all handrails and railings in accordance with the Contract Documents.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

### 1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all metal work specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials and Section 05050, Metal Fastening.

## PART 2 -- PRODUCTS

### 2.01 METAL MATERIALS

A. Metal materials used for handrails and railings shall conform to Section 05010, Metal Materials, unless noted otherwise.

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2.02 METAL FASTENING

A. All welds and fasteners used in handrails and railings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 HANDRAILS AND RAILINGS

A. General - Handrail systems shall consist of all railings, posts, toeboards, baseplates, anchors, and accessories required for a complete and rigid installation.

1. All handrail systems shall be fabricated from extruded aluminum alloy 6061-T6 or 6105-T5, with Aluminum Association M12C22A41 finish, unless otherwise noted.

2. Metal railings shall be fabricated from 1-1/2 inch Schedule 40 pipe. Metal railing support posts shall be fabricated from 1-1/2 inch Schedule 80 pipe.

3. The centerline of the top guard rail shall be 42 inches above the walking surface for level rail. For stair rail, the centerline of the top guard rail shall be 42 inches above the leading edge of the tread nosing. Stair handrail shall be 34 inches above the leading edge of the tread nosing. See Standard Detail 0552000.

4. Posts

a. Maximum horizontal spacing between posts for level rail shall be six feet.

b. Maximum horizontal spacing between posts for stair rail shall be five feet.

5. All rail joints shall be finished flush and shall occur only at supports. Posts shall not interrupt the continuation of the top rail at any point along the railing, including corners and end terminations. The top surface of the top railing shall be smooth and shall not be interrupted by projecting fittings.

6. Toeboards

a. Toeboards shall project 4-inches above the walking surface and shall not infringe on the minimum required walkway width.

b. Aluminum toeboards shall be extruded from aluminum alloy 6063-T6 unless otherwise noted.

c. Toeboards shall have a minimum thickness of 1/8" at any point. Geometry of toeboard shall closely resemble geometry shown on Drawings.

7. Expansion joint splices shall be provided at 30 foot maximum spacing and at all expansion joints in the structure supporting the handrail.

8. The handrail system shall be designed to resist the design loads specified by both OSHA and the International Building Code.

9. Provide handrail extensions at top and bottom of stairs and ramps in accordance with the International Building Code.

B. For metal handrail, the Contractor shall have the option of providing a handrail system of either an all welded type construction or a component type construction.

1. With both the all welded or component type construction, the baseplates and toeboards shall be furnished as shown on the Drawings.

2. Component Type System

a. All fittings and brackets shall be designed for stainless steel concealed set screws with internal tyne type connectors.

b. Exposed fittings shall be cast or extruded aluminum, or stainless steel to match ladder material, except where corrosion-resistant steel is employed as a standard fabricator's item for use.

c. Component type handrail shall be as manufactured by Thompson Fabricating Company, Inc., or Hollaender Manufacturing Company, Inc.

3. Welded handrail may be field assembled using component type fittings as described herein.

C. Handrail shall be either Type I or Type II handrail as shown on the Drawings. If no type is indicated on Drawings, handrail shall be Type I.

1. Type I handrail shall be a two-rail system. The centerline of the intermediate rail shall be 21 inches above the walking surface.

2. Type II handrail shall be a three-rail system with vertical posts spanning between the two intermediate rails.

a. The centerline of the lower intermediate rail shall be 7 inches above the walking surface.

b. The centerline of the upper intermediate rail shall be 5-3/4" below the centerline of the top rail.

c. Vertical posts spanning between the intermediate rails shall be 1/2" diameter schedule 40 pipe or fiberglass rod.

d. Spacing of vertical posts shall be as required to prevent passage of a 4-inch sphere at any point.

D. Where gates are required in handrails as shown on the Drawings, they shall be self-closing and shall be provided by the same manufacturer as the handrail. Gates shall swing away from the opening being protected by the handrail.

E. Where safety chains are required in handrails as shown on the Drawings, chains shall be constructed of Type 304 stainless steel. Chains shall be straight link style, 3/16-inch diameter, with at least twelve links per foot, and with snap hooks on each end. Snap hooks shall be boat type and eye bolts for attachment of chains shall be 3/8-inch bolts with 3/4-inch eye diameter welded to the railing posts. Two (2) chains, four inches longer than the anchorage spacing shall be supplied for each guarded area.

2.04 FREE STANDING RAILING SYSTEM

A. Free standing railing system shall be installed on roof ledges where accessible equipment is provided on roof and roof does not have a perimeter parapet wall of a minimum height of 42 inches. Free standing railing system shall be Safety Rail 2000 Guardrail System by BlueWater Mfg., Inc. or approved equal.

B. Toe Board brackets shall be used when the parapet wall is less than 3-1/2” in height.

C. Performance Characteristics: Shall meet and exceed OSHA (Standards - 29 CFR) 1926.502 (b).

1. Railing System shall be designed to withstand a minimum 200 pounds of test load in any direction.

2. Railing System shall consist of a top rail and rail at mid height between top rail and walking surface.

3. Railing system shall extend to a height of at least 42" from the finished roof deck.

4. Railing system shall be free of sharp edges and snag points.

D. Railing and Base

1. Rail shall be 1 5/8” O.D. Hot Rolled Pickled Electric Weld Tubing

2. Each support post shall have a free standing base cast from Class 30 Gray Iron material.

3. Each base shall have four (4) receiver posts for accepting the rails.

4. The receiver posts shall have a positive locking system. A friction locking system will not be acceptable.

5. The receiver posts shall have a slot to enable the rails to be mounted in any direction.

E. Hardware

1. The securing pins shall be made from 1010 carbon steel. The pins shall be zinc plated and yellow chromate dipped. The pins shall consist of a collared pin and a lanyard that connects to a lynch pin.

2. For Gate Assemblies Only. Bolts and washers shall be 3/8" x 3 ½" and 3/8" x 3" grade 5, zinc plated.

3. Finish: Rails: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

Bases: Specify factory finish Safety Yellow Powder Coat Paint, Hot Dipped Galvanized or a color to match the building.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with all adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. Concrete anchors and bolts for attachment of handrail baseplates to supporting members shall conform to Section 05050, Metal Fastening.

G. All fabricated items shall be shop painted in accordance with Section 09900, Painting.

3.02 INSTALLATION

A. Assembly and installation of handrails and railings shall be performed in strict accordance with manufacturer's recommendations.

B. All handrails and railings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

# SECTION 05531

# GRATINGS, ACCESS HATCHES, AND ACCESS DOORS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all gratings, floor plates, and hatches in accordance with the Contract Documents.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. Aluminum Association Specifications for Aluminum Structures

3. Occupational Safety and Health Administration (OSHA) Regulations

### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection Drawings of all gratings, access hatches, and access doors specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

## PART 2 -- PRODUCTS

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### 2.01 METAL MATERIALS

A. Metal materials used for gratings, floor plates, and hatches shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for gratings, floor plates, and hatches shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 GRATING

A. General - Grating, including support frames, fastenings, and all necessary appurtenances for a complete installation, shall be furnished as indicated on the Drawings.

1. All exposed bearing ends of grating shall be enclosed in a perimeter band of the same dimensions and material as the main bars, including ends at all cutouts.

2. Grating shall be fabricated into easily removable sections and shall be fastened at each corner and as required with fasteners provided by the grating manufacturer. No fasteners shall be permitted to project above the walking surface.

3. Grating shall be designed for a loading of 150 psf unless otherwise required by the Drawings. Grating deflection shall not exceed 1/4 inch under a uniform load of 100 psf. Minimum grating depth shall be 1-1/2 inches, unless structural requirements based on clear span require more depth.

B. Aluminum Grating

1. Aluminum grating shall be of I-bar type and shall consist of extruded bearing bars positioned and locked by crossbars. All supports, cross members, etc. shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel.

2. Grating shall be “19-SI-4 I-Bar Swage Locked” by Alabama Metal Industries Corporation (AMICO), “IB” by Harsco Industrial IKG, “I-Bar 19SGI4", by Ohio Grating Inc., or “I-Bar” by Thompson Fabricating LLC.

C. Aluminum Plank Grating

1. Aluminum plank grating shall be unpunched planks of extruded aluminum welded together to form panels. Panel ends shall have an extruded aluminum end bar welded in place. All support members shall be aluminum. Plank clips for grating holddowns or other required attachments, shall be aluminum or stainless steel. Bolts shall be stainless steel.

2. Aluminum plank grating shall be HD-P manufactured by Harsco Industrial IKG., Heavy Duty Series manufactured by Ohio Gratings, Inc., or Unpunched Duo-Grip Extruded Series manufactured by Alabama Metal Industries Corporation (AMICO).

D. Heavy Duty Steel Grating

1. Heavy duty steel grating shall be galvanized according to Section 05035, Galvanizing.

2. Main bearing bars shall conform to ASTM A36. Cross bars shall be flush with the top of the grating.

3. Grating span shall be 36 inches maximum and shall satisfy AASHTO loading for H-20 truck.

4. Grating shall be manufactured by Harsco Industrial IKG, Alabama Metal Industries Corporation (AMICO), and Ohio Gratings, Inc.

2.04 ACCESS HATCHES

A. Access hatches shall be aluminum unless noted otherwise.

B. All access hatches shall be checker plate with an approved raised pattern, non-skid surface.

C. Access hatches shall be designed to carry a minimum live load of 150 psf, or a concentrated load of 300 pounds at the center, whichever produces the greatest stress.

D. Access hatches shall not exceed an allowable fiber stress of 16,000 psi. Live load deflection shall be limited to L/240 of the span, but not more than 1/4-inch.

E. All access hatches shall be fabricated from 1/4" plate, minimum and shall be stiffened as required to maintain allowable stress and deflection requirements specified herein. Stiffeners shall consist of angles or bars welded to the bottom of the plate.

F. Hinges, where indicated on the Drawings, shall be insulated, heavy-duty, cadmium plated bronze with stainless steel pins and fasteners.

G. All access hatches as indicated on the Drawings shall be provided with recessed handles. Handle material shall be as shown on the Contract Drawings.

H. Air-tight and water-tight access hatches shall be provided with a 1/8 inch thick neoprene gasket between the checkered plate and the support frame. Gasket material shall be bonded to the support frame and access hatches shall be bolted to the structural support frame with countersunk stainless steel flathead screws.

2.05 ACCESS DOORS

A. General

1. Door opening sizes, number and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the clear opening dimensions.

2. All doors shall be aluminum unless otherwise noted.

3. Openings larger than 42 inches in either direction shall have double leaf doors.

4. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

5. All doors shall be provided with an automatic hold-open arm with release handle.

6. Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.

7. All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.

8. All doors shall be watertight with a continuous gasket. All single door applications shall include a continuous EPDM odor reduction gasket.

9. Door frames shall be extruded and equipped with a 1-1/2 inch minimum drain pipe located by the manufacturer. The drain pipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.

B. Floor, Wet Well and Dry Pit Access Doors

1. Door leaves shall be 1/4 inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.

2. Doors shall be designed for a 300 psf live load minimum, unless noted otherwise.

3. Doors shall be designed for flush mounting and for easy opening from both inside and outside.

4. All doors shall have an enclosed compression spring assist and open to 90 degrees.

5. Exterior doors shall be Type "J-AL" or "JD-AL", by Bilco Company, Type ”W1S” or “W2S” by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., Type "THG" or "THG-D", by Thompson Fabricating LLC.

6. Interior doors shall be Type "K" or "KD", by Bilco Company, Type ”S1S” or “S2S” by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., Type "TH" or "TH-D", by Thompson Fabricating LLC.

7. Doors rated for H-20 traffic loading shall be “JAL-HD” or “JDAL-HD” by the Bilco Company, Type “H1C” or “H2C” by Halliday Products, Inc., or Type “THS” or “THD” by U.S.F. Fabrication Inc.

C. Roof Access Doors

1. Doors shall be designed for 50 psf live load unless noted otherwise.

2. Doors for service stairs shall be Bilco Type L roof Scuttles.

3. Doors for ladder access shall be Bilco Type S or SS Roof Scuttles.

D. Fixed Ladders

1. Where the Contract Documents indicate fixed ladders are required under access doors, they shall be provided with “LadderUp, Model LU-4” by Bilco Company, “L1E Ladder Extension” by Halliday Products Inc., or “Ladder Climb-out Device” by Thompson Fabricating.

2. The safety posts shall be manufactured of the same material as the access door with telescoping tubular sections that lock automatically when fully extended.

3. Upward and downward movement shall be controlled by a stainless steel balancing mechanism.

4. Safety posts shall be assembled in strict accordance with manufacturer's recommendations.

2.06 FALL THROUGH PREVENTION SYSTEM

A. All access hatches and access doors covering openings measuring 12 inches or more in its least dimension through which persons may fall shall be equipped with a fall through prevention system, except where noted on the Contract Drawings. Access hatches and access doors shall be provided with a permanent installed fall through prevention grate system that provides continuous safety assurance in both its closed and open positions. The grate system shall be made with 6061-T6 aluminum or FRP and be designed for a 300 psf minimum liveload, unless noted otherwise.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All gratings, access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

C. Grating shall not be field cut or modified unless approved by Engineer.

D. Grating shall not be used for equipment support or anchorage.

- END OF SECTION -

# SECTION 05540

# CASTINGS

## PART 1 -- GENERAL

### 1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all castings in accordance with the requirements of the Contract Documents.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02604 – Utility Structures

B. Section 05010 - Metal Materials

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all castings specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

## PART 2 -- PRODUCTS

### 2.01 METAL MATERIALS

A. Metal materials used for castings shall conform to Section 05010, Metal Materials, unless noted otherwise.

### 2.02 METAL FASTENING

A. All welds and fasteners used for castings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

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2.03 IRON CASTINGS

A. General - Iron Castings shall include, but not be limited to frames, covers, and grates for trench drains, catch basins, and inlets/.

1. Castings shall be of gray iron of uniform quality, free from defects, smooth and well cleaned by shotblasting.

2. Catalog numbers on the Drawings are provided only to show required types and configuration. All covers shall be cast with raised letters as designated on the Drawings.

3. Castings shall be as manufactured by Dewey Brothers, or Neenah Foundry Company.

B. Covers and Grates

1. Covers and grates shall be provided with matching frames. Cover shall fit flush with the surrounding finished surface. The cover shall not rock or rattle when loading is applied.

2. Round covers and frames shall have machined bearing surfaces.

3. Design loadings:

a. Where located within a structure, a minimum design loading of 300 psf shall be used, unless noted otherwise.

b. At all locations not within a structure, the design loading shall be a standard AASHTO H-20 truck loading, unless otherwise noted.

C. Watertight gasketing, bolting, locking devices, patterns, lettering, pickholes, vents, or self-sealing features shall be as detailed on the Drawings.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.

C. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.

3.02 INSTALLATION

A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

B. All castings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

# SECTION 05550

# STAIR TREADS AND NOSINGS

## PART 1 -- GENERAL

### 1.01 REQUIREMENT

A. Furnish all materials, labor, and equipment required to provide all stair treads and nosings in accordance with the requirements of the Contract Documents.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05050 - Metal Fastening

C. Section 05510 - Metal Stairs

D. Section 06610 - Glass Fiber and Resin Fabrications

### 1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. 2012 International Building Code with 2013 Kentucky Amendments

2. Aluminum Association Specifications for Aluminum Structures.

### 1.04 SUBMITTALS

A. Submit the following in accordance with Section 01300, Submittals.

1. Complete fabrication and erection drawings of all work specified herein.

2. Other submittals as required in accordance with Section 05010, Metal Materials, and Section 05050, Metal Fastening.

## PART 2 -- PRODUCTS

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### 2.01 METAL MATERIALS

A. Metal materials used for stair treads and nosings shall conform to Section 05010, Metal Materials, unless noted otherwise.

2.02 METAL FASTENING

A. All welds and fasteners used for stair treads and nosings shall conform to Section 05050, Metal Fastening, unless noted otherwise.

2.03 SAFETY STAIR NOSINGS

A. Abrasive cast aluminum, safety stair nosings shall be provided on all concrete or concrete filled steel pan stairs, including the top stair of metal stairs that attach to concrete, and as shown on the Drawings unless noted otherwise.

B. Nosing shall be 3 inches wide and shall extend the full width of the stairway minus 3 inches on either side. Nosing shall be cast into the concrete and held in place with butterfly type extruded anchors.

C. The nosing shall be "Style 231-A", by Amstep Products, “Alumogrit Type 101", by Wooster Products, Inc., "Type AX", by Safe-T-Metal Company. For steel pan concrete filled stairs, nosing shall be "Type 101-SP", Wooster Products, Inc., or "Type AXPE", by Safe-T-Metal Company. For pan stairs, nosing shall be continuous over corner of stair treads to fully protect corner of treads from abrasion. All exposed fasteners shall be Type 304 stainless steel.

2.04 STAIR TREADS

A. Stair treads shall be aluminum with an abrasive nosing as shown on the Drawings.

B. Stair treads shall be designed for the live load specified in Section 05510, Metal Stairs.

C. Stair treads shall be as manufactured by IKG Industries, or Safe-T-Metal Company.

2.05 FRP STAIR NOSINGS

A. FRP stair nosings shall be provided on all concrete stairs in sodium hypochlorite areas and as indicated on the Drawings.

B. FRP stair nosings shall conform to Section 06610, Glass Fiber and Resin Fabrications as indicated on the Drawings.

2.06 FRP STAIR TREADS

A. FRP stair treads shall be provided for FRP stairs in sodium hypochlorite areas and as indicated on the Drawings.

B. FRP stair treads shall conform to Section 06610, Glass Fiber and Resin Fabrications.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.

B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, connections, brackets, and other details necessary for a complete installation shall be provided.

C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.

D. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.

E. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.

3.02 INSTALLATION

A. Assembly and installation of stair treads and nosings shall be performed in strict accordance with manufacturer's recommendations.

B. All stair treads and nosings shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions.

- END OF SECTION -

SECTION 05830

BEARING DEVICES AND ANCHORING

PART 1 -- GENERAL

1.01 THE REQUIREMENTS

A. The Contractor shall furnish and install bearing plates, pads, expansion devices, anchor rods and bolts and/or other devices used in conjunction with bearings and anchoring of bearing devices and assemblies at supports in accordance with this item and in conformity with the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05010 - Metal Materials

B. Section 05035 - Galvanizing

C. Section 05050 - Metal Fastening

D. Section 05120 - Structural Steel

E. Section 05140 - Structural Aluminum

F. Section 09900 - Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all work specified hereunder shall conform to the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section.

| | | |
|---|---|---|
| 1. | RMA Rubber Handbook | A4-F3-T.063-B2, Grade 2, Method B |
| 2. | ASTM A240, | Standard Specification for Heat Resisting Chromium and Chromium - Nickel Stainless Steel Plate and Sheet |
| 3. | ASTM A480 | Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip |
| 4. | ASTM D395, Method B | Standard Test for Rubber Property – Compression Set |
| 5. | ASTM D412 | Standard Test for Rubber Properties In Tension |
| 6. | ASTM D471 | Standard Test for Rubber Property - Effect of Liquids |

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| | | |
|---|---|---|
| 7. | ASTM D573 | Standard Test for Rubber-Deterioration In Air Oven |
| 8. | ASTM D575, Method A | Standard Test for Rubber Properties In Compression |
| 9. | ASTM D624, Die C | Standard Test for Rubber Property - Tear Resistance |
| 10. | ASTM D746 | Standard Test for Brittleness Temperature of Plastics and Elastomers by Impact |
| 11. | ASTM D792 | Standard Test for Specific Gravity and Density of Plastics by Displacement |
| 12. | ASTM D1149 | Standard Test for Rubber Deterioration - Surface Ozone Cracking In a Chamber (Flat Specimens) |
| 13. | ASTM D1785 | Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40 |
| 14. | ASTM D2240 | Standard Test for Rubber Property - Durometer Hardness |
| 15. | ASTM D2256 | Standard Test for Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method |
| 16. | ASTM D4894 | Standard Specification for PTFE Granular Molding and RPM Extension Materials |
| 17. | ASTM D4895 | Standard Specification for PTFE Resin Produced From Dispersion |

1.04 SUBMITTALS

A. Submit the following in accordance with the requirements of Section 01300, Submittals:

1. Certification of compliance that the materials furnished under this section meet and conform to the property and physical requirements, including all testing, as stated herein and as referenced. Specifically, the certification shall state compliance with the applicable standards (ASTM, ANSI, etc.) for fabrication and testing.

2. Shop Drawings for all materials, including installation and adjustment instructions. Included with the Shop Drawings shall be all material certifications, mill test results, working drawings, etc., which are required by this and other applicable sections of the Specifications.

PART 2 -- PRODUCTS

2.01 ELASTOMERIC BEARING PADS

A. The elastomer portion of pads shall be new neoprene compound. Pads shall be cast under heat and pressure and may be individually molded or cut from pressure-cast stock.

Variations from the dimensions shown on the Drawings shall not be more than the following: thickness, ±1/16 inch; width, -1/8 to +1/4 inch; length, -1/8 to +1/4 inch. Tolerances, dimensions, finish and appearance, flash, and rubber-to-metal bonding shall conform to the requirements of A 4-F3-T.063-B2, Grade 2, Method B, in accordance with the RMA Rubber Handbook. Pads shall be furnished in one piece and shall not be laminated unless otherwise specified. Pads shall be furnished in identifiable packages.

B. Adhesive for use with elastomer pads shall be an epoxy-resin compound compatible with the elastomer having a sufficient shear strength to prevent slippage between pads and adjacent bearing surfaces. Adhesive shall be 20$^{+}$F Contact Cement by Miracle Adhesives Corporation, Neoprene Adhesive 77-198 by IGI Adhesives, Sikodur 31, Hi-Mod Gel by Sika Corporation, or DP-605 NS Urethane Adhesive by 3M Adhesive Systems.

C. Laminated pads shall consist of alternate laminations of elastomer and hot-rolled steel sheets molded together as a unit. Outer metal laminations shall be 3/16 inch, and inner laminations shall be 14 gage. Outer laminations of elastomer shall be 1/4 inch, and inner laminations shall be of equal thickness (at least 3/8 but not more than 1/2 inch), depending on the number of laminations and thickness of the pad. Edges of metal laminations shall have a cover of approximately 1/8 inch of elastomer. The top and bottom bearing surfaces shall each have an integral sealing rib approximately 1/8 inch in depth, in addition to the specified total thickness, and 3/16 inch in width around their peripheries. The bond between the elastomer and metal shall be such that failure shall occur in the elastomer and not between the elastomer and steel when tested for separation. Variations from specified dimensions for individual laminations shall not be more than those specified herein. The total thickness of the complete pad shall not vary more than ±1/8 inch.

D. Material having a nominal durometer hardness of 70 and 50 shall be used for nonlaminated pads and laminated pads, respectively. Test samples will be prepared from finished pads. Samples of each thickness will be taken from 2 full-size pads from each shipment of 300 pads or less, with 1 additional pad for each additional increment of 300 pads or fraction thereof. When tested using the ASTM methods designated, samples shall comply with the following physical requirements.

1. **Original Physical Properties:** Test results for tear resistance, tensile strength, and ultimate elongation shall not be more than 10 percent below the following specified value:

| | **Nominal Hardness** | |
|---|---|---|
| | **50** | **70** |
| Min. tear resistance, ASTM D624, Die C (lb/in of thickness) | 180 | 200 |
| Hardness, ASTM D2240 (points) | 50±5 | 70±5 |
| Min. tensile strength, ASTM D412 (average psi of longitudinal and transverse) | 2,500 | 2,500 |
| Min. ultimate elongation (%) | 400 | 300 |

The compressive deflection tested in accordance with ASTM D575, Method A, shall be as follows:

a. **Laminated Pads:** The maximum compression deflection shall be 5 and 7 percent of the total rubber thickness at loads of 500 and 800 pounds per square inch, respectively. The maximum shear resistance shall be 50 pounds per square inch of the plan area at 25 percent shear deformation at –20°F. Test pads shall be subjected to a compressive load of 1.5 times the maximum design load without visible damage to the bearing.

b. **Nonlaminated Pads:** When loaded within 300 to 800 pounds per square inch, material shall show a compressive deflection within 20 percent of that given in the charts of Method A, interpolating for actual measured hardness.

2. **Changes in Original Physical Properties:** When pads are oven aged 70 hours at 212°F in accordance with ASTM D573, changes shall not be more than the following:

| **Property** | **Value** |
|---|---|
| Hardness (points change) | 0 to +15 |
| Tensile strength (% change) | ±15 |
| Ultimate elongation (% change) | -40 |

3. **Extreme Temperature Characteristics:** Compression set under constant deflection, ASTM D395, Method B, 22 hours at 212°F, shall not be more than 35 percent. With the low-temperature brittleness test, ASTM D746, breaks shall not occur above –20°F.

4. **Ozone Cracking Resistance:** Upon exposure to 100 parts per million of ozone in air by volume at a strain of 20 percent and a temperature of 100±2°F in a test otherwise in accordance with ASTM D1149, cracks shall not develop within 100 hours. Samples shall be wiped with solvent before the test to remove traces of surface impurities.

5. **Oil Swell:** The volume change shall not be more than +120 percent when tested in accordance with ASTM D471 with ASTM Oil No. 3, 70 hours at 212°F.

2.02 TFE BEARING SURFACES

A. TFE resin shall be virgin material conforming to the requirements of ASTM D4894 or D4895. The specific gravity shall be 2.13 to 2.19. The melting point shall be 623±2°F.

B. Filler material shall be milled glass fibers, carbon, or other approved inert filler materials.

C. Adhesive material shall be an epoxy resin conforming to FS MMM-A-134, FEB film or equal, as approved by the Engineer.

D. When tested in accordance with ASTM D4894 or D4895, finished unfilled TFE sheets shall have a tensile strength of at least 2,800 pounds per square inch and an elongation of at least 200 percent.

E. Filled TFE sheets shall contain inert filler material uniformly blended with TFE resin. Finished filled TFE sheets containing glass fiber or carbon shall conform to the following:

| | ASTM Method | 15% Glass Fibers | 25% Carbon |
|---|---|---|---|
| Min. tensile strength | D4894/D4895 | 2,000 psi | 1,300 psi |
| Min. elongation | D4894/D4895 | 150% | 75% |
| Min. specific gravity | D792 | 2.20 | 2.10 |
| Melting point | D4894/D4895 | 327±10°C | 317 ±10°C |

F. Fabric containing TFE fibers shall be manufactured from oriented multifilament TFE fluorocarbon fibers and other fibers as required by specific designs. When tested in accordance with ASTM D2256, the tensile strength of TFE fibers shall be at least 24,000 pounds per square inch and the elongation shall be at least 75 percent.

G. Where TFE sheets are to be epoxy bonded, one surface of the sheet shall be factory treated by an approved manufacturer using the sodium naphthalene or sodium ammonia process.

H. Stainless steel mating surfaces shall be at least 16 gage in thickness and shall conform to the requirements of ASTM A240, Type 304. The mating surface shall be a true plane surface with a Brinnell hardness of at least 125 and a surface finish of an at least No. 8 mirror finish in accordance with ASTM A480. Stainless steel mating surfaces shall be polished or rolled as necessary to conform to the friction requirements specified herein. The stainless steel shall be attached to the sole plate by means of a seal weld around the entire perimeter of the facing material.

I. The coefficient of friction for the completed bearing assembly shall not be more than the following:

| Material | Bearing Pressure | | |
|---|---|---|---|
| | 500 psi (3.447 MPa) | 2,000 psi (13.790 Mpa) | 3,500 psi (24.132 MPa) |
| Unfilled TFE, fabric Containing TFE fibers, TFE perforated metal composite | .08 | .06 | .04 |
| Filled TFE | .12 | .10 | .08 |
| Interlocked bronze and filled TFE structures | .10 | .07 | .05 |

2.03 PREFORMED FABRIC BEDDING MATERIAL

A. Material shall be composed of multiple layers of 8-ounce cotton duck impregnated and bound with high-quality natural rubber or its equivalent and equally suitable materials compressed into resilient pads of uniform thickness. The number of plys shall be such as to produce the specified thickness after compression and vulcanizing. Finished pads shall withstand compression loads perpendicular to the plane of the laminations of at least 10,000 pounds per square inch without a detrimental reduction in thickness or extrusion.

2.04 ANCHOR RODS

A. Anchor bolts shall be as specified in Section 05050, Metal Fastening.

2.05 PIPE SLEEVES AND COLLARS

A. Pipe sleeves and collars shall be cut from schedule 40 PVC plastic pipe meeting the requirements of ASTM D1785 unless otherwise noted on the Drawings.

PART 3 -- EXECUTION

3.01 STEEL PLATES, SHAPES, AND BARS

A. Unless galvanizing is indicated on the Drawings, items shall be painted in accordance with the Drawings and Section 09900, Painting.

B. If galvanizing is indicated on the Drawings, steel bearing assemblies for both structural steel beams and girders and prestressed concrete members shall be galvanized as specified in Section 05035, Galvanizing. Except for attachments of bearing plates to beams, all fabrication and welding of bearing plate assemblies shall be performed before the steel is galvanized. All joints of welded parts shall be sealed with weld material. Welds made for attaching bearing plates to beams or girders shall be cleaned and given 2 coats of zinc rich paint having a minimum total coating thickness of 3 mils.

3.02 BRONZE PLATES

A. Sliding surfaces of bronze plates shall be polished.

3.03 COPPER-ALLOY PLATES

A. Finishing of rolled copper-alloy plates will not be required provided their surfaces are plane, true, and smooth.

3.04 SELF-LUBRICATING PLATES

A. Plates shall be fabricated from cast bronze or rolled copper alloy.

B. Sliding surfaces of plates shall be provided with annular grooves or cylindrical recesses or a combination thereof, which shall be filled with a lubricating compound. The lubricating compound shall be compressed into recesses under sufficient pressure to form a nonplastic lubricating inset. The inset shall comprise at least 25 percent of the total area of the plate. The frictional coefficient shall not be more than 0.10. The compound shall be free from material that will cause abrasive or corrosive action on metal surfaces and able to withstand extremely high pressures and atmospheric elements over long periods of time.

C. Items shall be the standard products of the manufacturer of such materials for the application.

D. Prior to assembly, the steel surface that will bear on the self-lubricating bearing plate shall be thoroughly lubricated with additional antioxidant lubricant furnished by the manufacturer. Coatings shall be removed before application of antioxidant lubricant.

3.05 ELASTOMERIC PADS

A. Care shall be taken in fabricating pads and related metal parts so that effects detrimental to their proper performance, such as uneven bearing and excessive bulging, will not occur.

3.06 PLACEMENT OF BEARING PLATES AND PADS

A. Bearing areas shall be finished to a true level plane which shall not vary perceptibly from a straightedge placed in any direction across the area.

B. Bearing plates or pads shall be set level in exact position and shall have a uniform bearing over the entire area. Provision shall be made to keep plates or pads in the correct position during erection of beams or placement of concrete.

C. Elastomeric pads and other flexible bearing materials shall be placed directly on masonry surfaces finished to a roughness equivalent to that of a No. 36 to No. 46 grit. Pads, bearing areas, or bridge seats and metal bearing plates shall be thoroughly cleaned and free from oil, grease, and other foreign materials. Metal bearing plates or bottoms of prefabricated beams that are to bear on elastomeric pads shall be coated with epoxy and then surfaced with a No. 36 to No. 46 silicon carbide or aluminum oxide grit. Bearing areas shall be finished to equivalent roughness.

D. Metal bearing plates shall be bedded on seats as follows:

1. The seat bearing areas shall be thoroughly swabbed with approved paint, and three layers of duck, 12 to 15 ounce per square yard, shall be placed on it, each layer being thoroughly swabbed with paint on its top surface.

2. Superstructure shoes or pedestals shall be placed in position while paint is plastic. As an alternate to duct and paint, preformed fabric bedding material at least 1/8 inch in thickness may be used when called for on the Drawings or approved in writing by the Engineer.

3.07 PLACEMENT OF ANCHOR RODS

A. All necessary anchor rods and bolts (anchors) shall be accurately set either in the concrete as they are being placed, in formed holes, or in holes cored after the concrete has set. If set in the concrete, the rods and bolts shall be accurately positioned by means of templates and rigidly held in position while the concrete is being placed. Holes may be formed by inserting or casting in the fresh concrete oiled wooden plugs, metal pipe or plastic sleeves, or other approved devices, and withdrawing them after the concrete has partially set or left in place as indicated on the Drawing's or approved by the Engineer. Holes so formed shall be at least 3 inches in diameter or at least 2.5 times the diameter of the rod or bolt. If cored, holes shall be at least 2.5 times the diameter of the anchor used or as indicated on the Drawings. Equipment used for coring concrete shall have been approved by the Engineer. Impact tools will not be permitted. Reinforcing steel shall be placed to provide adequate space to core rod/bolt holes without cutting the reinforcing steel. For cored holes, anchor rods and bolts shall be adequately held in place at the centroid of the hole or as specified on the Drawings by using approved pre-fabricated equalizers designed to allow grout to penetrate and fill the hole completely and spaced as approved by the Engineer.

B. During freezing conditions, anchor holes shall be protected from water accumulations at all times.

C. Anchors which are to be placed in holes of sufficient and specified diameter after the concrete has set shall be bonded to the concrete with a non-shrink high-strength Portland cement grout in accordance with Section 03600 – Grout or shall be adhesive anchors in accordance with Section 05050 - Metal Fastening. The type anchoring system and grout shall be as indicated on the Drawings. The grout or adhesive shall completely fill the holes. Anchors shall be tested for sufficient pull-out capacity as indicated in applicable sections of the Specifications or as indicated on the Drawings.

D. Anchors that are not designed to project through bearing plates shall be checked for proper projection above the masonry bearing area immediately prior to placement of bearing plates and beams. Nuts on anchor rods at expansion ends shall be adjusted to permit free movement of the span.

E. Angles for anchor assemblies to be attached to sides of concrete beams shall not be installed until beams have received their full dead load and supporting falsework has been removed.

- END OF SECTION -

SECTION 06100

ROUGH CARPENTRY

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on the Drawings and specified herein.

B. Principal items of work include:

1. Wood blocking, nailers, grounds, furring, ties, centering, etc., necessary or required for attachment or support of work under this Section, and other Sections.

2. Fasteners, including nails, screws, bolts, anchors and other fastenings, required to secure work under this Section.

3. Temporary enclosures and protective boarding.

4. Wood preservative treatment for all wood members in contact with roofing, masonry, concrete, and exposed to the elements.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. AWPA-CA Preservative Standards, Lumber and Plywood.

2. AWPA-C20 Structural Lumber Fire-Retardant Treatment by Pressure Process.

3. AWPC-C27 Plywood Fire-Retardant Treatment by Pressure Process.

4. AWPA-M4 Standards for Care of Preservative Treated Wood Products.

5. APA Guide to Plywood Grades.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Certifications of Preservative and Fire Retardant Treatment.

2. Warranty of treatment manufacturer.

3. Certification of type and grade of lumber to be used.

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4. Certification of type, rating and conformance to APA Standards.

1.04 DELIVERY AND STORAGE

A. Take all measures necessary to protect products against damage during delivery and storage.

B. Store lumber in enclosed places in such a manner to provide ventilation and protection from the weather.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Blocking, nailers, grounds and the like: Eastern Spruce or Douglas Fir - No. 3 Dimension Lumber or Construction Grade, with a moisture content not to exceed 19%.

B. Plates, blocking, and nailers in contact with masonry: Pressure treated southern yellow pine.

C. Plywood: Identified with APA Grade trademarks of the American Plywood Association, in thickness as shown on the Drawings.

1. Exterior: AC-EXT-APA where exposed to view or a finish is required, CD-EXT-APA where concealed.

2. Interior: AC-INT-APA where exposed to view or a finish is required, CD-INT-APA where concealed.

D. Structural Framing Lumber: Douglas Fir No.1 grade with fb = 1,500 pounds per square inch and E = 1,700,000 pounds per square inch, 19 percent moisture content.

E. Fasteners: Provide clamps, connectors, straps, nails, bolts, screws, anchors, ties and other accessories and fasteners shown or required to properly secure all rough carpentry. Fasteners and accessories shall be stainless steel, galvanized, or other noncorrosive metal recommended for use.

F. Wood Preservative Treatment: Disodium octoborate tetra hydrate pressure treatment in conformance with the American Wood Preservers' Association standard P5. Retention shall be in accordance with AWPA Standards and be a minimum of 0.40 pounds per cubic foot. Stamp each piece of treated wood with a trademark identifying the classification of the treatment or a certificate from the processor for each shipment.

G. Fire Retardant Treatment: Fire-retardant lumber and plywood must have an Underwriters Laboratories stamp signifying a FR-S rating and certifying a 25 or less flame spread and smoke developed value, when tested in accordance to UL 723, ASTM E 84, and NFPA 255 "Tunnel Test", and when the test is extended for 20 additional minutes. Treatment formulation shall contain no halogens, sulfates, chlorides or ammonium phosphate. Smoke toxicity shall be no more than that of untreated wood.

PART 3 -- EXECUTION

3.01 COORDINATION

A. Coordinate with all trades as to nailers, blocking, grounds and the like required for the attachment of their work and other items requiring same. Carry out all work as required to cooperate work of other trades.

3.02 INSTALLATION

A. Perform work in conformance manufacturer's recommendations and specifications, industry, national and local standards and codes.

B. Layout, cut, fit and erect rough blocking, nailers, furring and other rough carpentry. Do cutting work in connection with carpentry and finish for other trades. Brace plumb and level all members in true alignment and rigidly secure in place with sufficient nails, spikes, screws and bolts. Defects which render any piece or part unable to serve its intended purpose shall be discarded or, cut out and replaced.

C. Provide all bracing, supports and shoring required to support construction.

D. Protect all masonry including edges of concrete platforms and similar items. Remove protective covering when directed. Take special precautions at masonry openings and corners of the building.

E. Set all rough hardware, such as plates, spikes, bolts, nails, lag screws, lagging bolts, anchors, etc., as required to hold woodwork together or to anchor or secure it to other materials and construction.

F. Provide wood grounds, nailing strips and similar items wherever necessary or required throughout the project for the support, proper erection or installation of the work and support of mirrors, cabinets, shelf cleats, base and similar items. Thoroughly secure in place by approved means.

G. Secure wood grounds, nailing strips and similar items to metal plugs set in masonry, toggle or expansion bolts. Give the mason all necessary information to enable him to lay out correctly the location for metal wall plugs. Wood plugs will not be accepted.

H. Construct joints to support dead loads, live loads, snow loads, wind loads, or combinations in conformance with "National Design Specifications for Stress Grade Lumber and its Fastenings", recommended by National Forest Products Association.

I. Nailers and Blocking: Provide and secure wood nailers, blocking, for the reception of roof curbs, roofing, etc.

1. Provide nailers of sizes, shapes and profiles indicated on the Drawings or as required. Provide with anchors as indicated, recommended or required for secure attachment.

3.03 TEMPORARY PROTECTION

A. Provide and install all temporary protection in accordance with applicable provisions of the Contract Documents, OSHA regulations, and as follows:

1. Temporary protection shall include wood doors, railings, protection of floor or roof openings, temporary partitions, and the like; adequately maintained in good repair during the life of the Contract.

2. Furnish and set temporary partitions with wood doors at all exterior doorways, exterior openings or in locations exposed to weather. Substantially build and hang, with proper hinges, locks and other necessary hardware, and remove and reset whenever required to accommodate the Work and keep in good repair.

3. Provide substantial temporary wood covering or guards for openings left in floor or roof slabs for ducts, shafts, etc., using rough planking at least 2 inch thick, cleated together and otherwise made sufficiently strong and put in place wherever required immediately after the forms have been removed.

3.04 JOB CONDITIONS

A. If the installation of metal frames and glass does not promptly follow the completion of the exterior enclosures, and if the absence of enclosures would cause damage, close in all such openings temporarily by the use of heavy polyethylene plastic sheeting, or canvas stretched over and nailed to frames of 1 inch x 2 inch or heavier strips.

3.05 REMOVAL OF TEMPORARY WORK

A. Remove all temporary protection when so directed, or prior to acceptance of this project.

- END OF SECTION -

SECTION 06610

GLASS FIBER AND RESIN FABRICATIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install all fiberglass items as specified herein and as shown on the Drawings. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 05050, Metal Fastening

B. Section 07900, Joint Fillers, Sealants, and Caulking

C. Section 09900, Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM D2996 – Specification for Filament Sound Reinforced Thermosetting Resin Pipe

2. ASTM D3647 - Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition

3. ASTM D3917 - Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes

4. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products

1.04 SUBMITTALS

A. Submit shop drawings showing fabrication details and a Performance Affidavit for all items specified herein in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions.

B. Certification of compliance with ASTM Standards.

C. Where specifically requested, design calculations sealed by a currently Registered Professional Engineer in the State of Indiana.

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1.05 QUALITY ASSURANCE

A. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

B. It shall be the Contractor's responsibility to ensure the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.

C. Manufacturer shall provide a 3 year warranty on all FRP products against defect in material and workmanship.

PART 2 -- MATERIALS

2.01 GENERAL

A. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples.

B. Ultraviolet light resistive resins shall be used for all exterior locations and where specified.

C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.

D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

2.02 GRATING AND TREADS

A. Fiberglass grating and treads shall be furnished and installed in areas shown on the Drawings including all FRP angle supports, fasteners and accessories. Gratings and treads shall consist of extruded bearing bars positioned and locked by crossbars. Grating and treads shall be installed in accordance with the manufacturer's recommendations.

B. Grating shall be fabricated into easily removable sections as large as possible up to 150 lbs. per section.

C. Fasteners shall not project above the walking surface.

D. Fiberglass grating and treads shall be manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Grating and treads shall be produced by IKG Industries, Fibergrate, Inc., IMCO Reinforced Plastics, Inc., or equal.

E. Grating shall be designed for a uniform loading of 100 PSF over the gross projected area with deflection limited to 0.375" or grating span/240 whichever is less. Fiberglass or PVC support beams shall be provided as required to meet deflection criteria.

F. The grating and tread supplier shall supply all shelf support angles, embedded angles with anchors, concrete anchors and necessary 316 stainless steel grating clips coated with epoxy paint per Section 09900, Painting, for a complete system.

G. Treads shall be designed for a 300 lb. concentrated load at midspan. Treads shall be furnished with integral nosing.

2.03 FIBERGLASS WEIRS AND BAFFLES

A. Fiberglass reinforced polyester (FRP) weirs and baffles shall be installed where shown on the Drawings. All weir plates, scum baffle plates, buff plates, and cover plates shall be FRP. A "low profile" resin system shall be used to insure that all surfaces are smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas to provide increased corrosion and weather resistance. All edges shall be sealed in the mold. Resin shall be of the isopthalic type. Plate thickness shall be 3/8-inch minimum, or as shown on the Drawings. FRP weirs and baffles shall be blue-green in color. Each section shall be of the depth and overall length as indicated on the Drawings. Each section shall be provided with mounting holes at 12 inches on center, unless shown otherwise on the Drawings, to provide a minimum 2-inch vertical or horizontal adjustment. Sections shall be secured to walls or trough with 316 stainless steel anchor bolts and 5-inch minimum diameter washers to prevent short-circuiting. Ends of weir plates shall be secured with 6-inch wide butt plates arranged to allow for horizontal expansion. Type 316 stainless steel anchor bolts shall be furnished by the FRP supplier.

B. Laminate shall contain a glass content of 30$\pm$2% using Type "E" glass with chrome or silane finish. Powdered reinforcements shall consist of 47.5$\pm$1% of resin mixture. Final laminate thickness shall be within $\pm$10 percent of the nominal specified thickness. Ultraviolet absorbers shall be added to the resin to prevent deterioration from sunlight. Where weir plates are of non-standard length or non-standard mounting hole configuration, such machined or cut edges shall be resin sealed with seal mix.

C. All items shall be manufactured in accordance with ASTM D2996 and ASTM D3917. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples to verify that the laminate has the following minimum physical properties:

| Requirement | Minimum Results | Test Method |
|---|---|---|
| Tensile Strength (psi) | 14,000 | ASTM D 638 |
| Flexural Strength (psi) | 25,000 | ASTM D 790 |
| Flexural Modulus (psi) | $1.0 \times 10^{6}$ | ASTM D 790 |
| Impact, Notched, Izod, (foot pound per inch) | 15.0 | ASTM D 256 |
| Barcol Hardness | Minimum, 35 Average, 40 | ASTM D2583 |
| Water Absorption, (% 24 hours) | 0.1 | ASTM D 570 |
| Average coefficient of thermal expansion (inch per inch per °F) | $10.5 \times 10^{-6}$ | ASTM D 696 |

D. The procedure used in determining the above properties shall be in accordance with the ASTM Standards, Part 35, using the method designated above. Hardness tests shall be made on the resin rich surfaces of the test samples. Test coupons shall be prepared in accordance with the appropriate ASTM test method.

E. Baffle plate lengths shall be made to fit the installation but lengths shall not exceed 10 feet. Lap plates shall be provided to secure the ends of the plates. Type 316 stainless steel hardware shall be furnished by the FRP supplier for securing baffle plates to 316 SS support brackets and lap plates. Type 316 SS anchor bolts shall be used for anchoring scum baffle supports to the wall.

F. All items furnished under this Section shall be as manufactured by PLASTI-FAB, Inc., Warminster Fiberglass, Leopold, or equal.

2.04 FILTER BACKWASH TROUGHS

A. Effluent troughs shall be furnished and installed as shown on the Drawings. Troughs shall be manufactured by Fiberglass Fabricators, Inc., or Leopold Company, Division of Sybron Corporation, or Plasti-Fab, Inc., or equal.

B. Effluent troughs shall be constructed of fiberglass reinforced polyester (FRP), and shall be the length indicated with approximately 18-inches inside width and 21-inches depth as shown on the Drawings. Each trough shall have a minimum wall thickness of 1/4-inch, and shall be reinforced with triangular shaped longitudinal stiffener sections molded as an integral part of the trough. Maximum vertical deflection under maximum loading conditions (150 lbs./lin. ft. upward and downward) shall not exceed 3/16-inches at mid-span between supports. Sidewall horizontal alignment shall be + 1/8-inch over the entire trough length. Trough joints shall be designed for + 1/8-inch thermal expansion or contraction without stressing the structure. Each trough shall consist of a maximum of four (4) sections, and shall be connected with a watertight seal. Trough color shall be blue-green translucent and include an ultraviolet light blocking agent added to the resin. An integrally molded water stop shall be provided on the discharge end of each trough. The closed end of the trough shall be integrally molded during trough construction to a minimum of 3/8-inch thickness and arranged for bolting to the basin. Trough intermediate supports shall be 316 stainless steel and connected to the overhead concrete support beams. Each intermediate and rear support shall provide means of vertical adjustment. All support hardware, metal components and angles shall be 316 (or 316L) stainless steel and shall be provided by trough manufacturer. Carbon steel, brass, bronze and aluminum inside the filter box shall not be acceptable. The manufacturer shall submit details of supports with calculations showing vertical and horizontal deflection, support calculations and physical properties of the FRP.

C. Effluent troughs shall be provided with adjustable weir plates, minimum 2-inch adjustment, which are completely independent of any trough stiffening members. Weir plates are described above.

D. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with 3 ounces or more of chopped strand glass laminate in a minimum of two (2) layers. Final laminate thickness shall be within a tolerance of plus 1/16-inch or minus "O" of minimum laminate thickness. Void content of the complete laminate shall not exceed 2-1/2 percent of laminate volume.

E. The manufacturer shall certify that troughs and the testing of the trough materials is in complete compliance with the latest ASTM Standards. Copies of the certified test reports on the troughs shall be submitted to the Engineers in addition to the required calculations and physical properties stated in these Specifications.

2.05 PARSHALL FLUME

A. Parshall flume liners shall be a full length, molded fiberglass reinforced polyester with throat width as shown on the Drawings. The interior dimensions of the flume shall conform to that shown in the latest revision of the U.S. Department of Interior Bureau of Reclamation, Water Measurement Manual. The flume liner shall be fabricated in one piece from polyester plastic resin, reinforced by glass mat not less than 30 percent be weight. The thickness of the walls shall be 1/4-inch minimum. Locking clips shall be so designed to be an integral part of the liner and of sufficient number to insure permanent alignment. Temporary bracing shall be provided to assure maintenance of dimensions during shipment and installation. Flume liner shall have a staff gauge graduated in feet with 50 divisions per foot attached to the inside wall of the flume.

2.06 FRP STOP PLATES

A. Furnish FRP stop plates as specified herein and as shown on the Drawings.

B. Stop plates shall be constructed of fiberglass reinforced polyester containing ultraviolet absorbers and having a resin rich surface on both sides, thoroughly embedding all glass fibers, and shall be blue-green in color. Plates shall have sandwich core structural reinforcing throughout the high stress areas with the thickness as recommended by the manufacturer. The reinforcing shall be encapsulated with laminate of fiberglass and polyester not less than 1/8-inches thick on each side to insure against permeation by water to the sandwich core material. The stop plates shall be molded individually to the exact size required. Plates cut from flat stock are not acceptable.

C. Each stop plate shall contain reinforced handholes for installation and removal. Stop plates greater than two (2) feet in width shall have a minimum of two (2) handholes. Stop plates less than two (2) feet in width shall have a minimum of one (1) handhole.

D. Guide frames shall be surface mounted with 316 stainless steel anchor bolts, or shall be embedded in concrete as shown on the Drawings. All stop plates shall be sealed with neoprene rubber to form a watertight seal.

E. The mechanical properties of the laminate used in the manufacture of the stop plates shall be as follows:

Laminate Physical Properties 73°F

| | ASTM Test Method | Minimum Properties |
|---|---|---|
| Ultimate Tensile Strength - PSI x $10^3$ (Min.) | D-638 | 12 |
| Flexural Strength - PSI x $10^3$ (Min.) | D-790 | 19 |
| Flexural Modulus of Elasticity - PSI x $10^6$ (Min.) | D-790 | .8 |
| Barcol Hardness (Min.) | D-2583 | 35 |
| Water Absorption (24 Hours) | D-570 | 2% Max. |

2.07 FIBERGLASS (FRP) LOUVERS

A. Louvers furnished under this Specification apply to all louvers up to 24" x 24", and shall be shipped from the manufacturer's shop as completed units, ready for installation, packaged in cardboard or crated as required, together with mullions, trim, and accessory items which may be necessary for final installation. Field fasteners into steel or concrete to be supplied by Contractor.

B. Each piece, part, or unit shall be clearly identified with a chemical resistant tag, showing manufacturer's drawing number, part number, and location.

C. All louvers furnished under this Specification shall meet the following requirements.

Design

1. Louvers shall be fabricated from pultruded FRP structural shapes, using non-metallic pivot pins and epoxy bonded joints.

2. Adjustable louvers shall be supplied in individual units up to 48-inches wide. Fixed units shall be in widths up to 12 feet, with integral blade supports installed at 36-inch centers.

3. FRP mullion columns shall be used to subframe large openings for placement of multiple louver units. Metallic fasteners shall be Type 304 stainless steel, unless otherwise specified.

4. Standard louvers (fixed and adjustable) shall be 4-inches deep using "storm-proof" type blades, with a blade angle of 35 from the horizontal when open, and 45 percent minimum free area.

5. Standard manual lever-type positive locking operators shall be used on each adjustable unit. Spring and chain, gang, and air cylinder operators are available and should be so specified when required.

6. 1/2-inch mesh PVC bird screen shall be shop installed.

Material

1. All material supplied under this Specification shall be made from premium grade, chemical resistant, fire retardant, glass reinforced structural members, utilizing a synthetic surface mat to minimize the effects of ultraviolet degradation.

   a. Flame-spread - 25 max. (ASTM E-84)

   b. Pigmented grey throughout

      Mechanical properties:

| | | |
|---|---|---|
| (1) | Ultimate tensile strength | 30,000 psi |
| (2) | Ultimate compressive strength | 30,000 psi |
| (3) | Modulus of elasticity | $2.5 \times 10^6$ |
| (4) | Barcol hardness | 50 |

2. Nonstructural fasteners shall be nylon, structural fasteners shall be 316 stainless steel, unless otherwise specified.

Workmanship

1. All cut edges and holes shall be sealed with a compatible resin.

2. All work shall be square and true; blades shall not bind in operation.

3. Surfaces shall be free of fiber blemish.

Source

1. Louvers shall be as manufactured by IMCO Reinforced Plastics, Inc., 858 N. Lenola Rd., Moorestown, N.J. 08057, or approved equal.

2. Manufacturer shall submit Shop Drawings for approval, and fabrication shall not proceed until time of approval by the purchaser or other authority.

2.08 MANHOLE LADDERS

A. The ladders shall be of fiberglass construction with pultruded structural channel shapes, non skid grit surfaces used on top surface of each rung and a synthetic surfacing veil for chemical and ultraviolet resistance and high strength. Ladders shall possess Class one fire retardant, with an ASTM E-84 flame-spread rating of 25 maximum and shall conform to OSHA 1910.27. Color shall be safety yellow (beige for immersed ladders).

B. Ladders shall utilize channel side rails and 1-3/8 inch minimum diameter round rungs. Rung to side connections shall utilize a keyed, pinned and bonded joint for prevention of rung rotation and pullout. The ladders shall be attached to the bracket angles with two stainless steel bolts, washers and nuts per angle bracket.

C. Concrete anchors shall be minimum 5/8 inch diameter with 3 inch embedment and shall comply with Section 05050, Metal Fastening. Fiberglass pultruded parts shall be Extren,

Series 525 except for sodium hypochlorite applications where vinyl ester resin shall be used. Shades shall be manufactured by Strongwell, Inc., or equal. Ladders shall conform to OSHA requirements and to the details shown on the Drawings.

2.09 FIXED LADDERS

A. Provide fixed ladder systems with all safety cages, landings, mounting clips, fasteners, and necessary appurtenances for a complete and rigid installation.

B. The ladder systems shall be designed to meet or exceed all OSHA requirements.

C. Ladders and cages shall be fabricated from pultruded shapes conforming to Extren Series 525 except for sodium hypochlorite applications where Extren Series 625 shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

D. Ladder side rails shall be fabricated from channel members or 2 inch minimum square tube.

E. Side rails shall be anchored with FRP standoff clips manufactured of polyester resin except for sodium hypochlorite applications where vinyl ester resin shall be used. Clips shall be placed at the top and bottom of the ladder and at 6 foot maximum vertical centers.

F. Rungs

1. Rungs shall be 18 inches long, serrated and covered with a silica grit to produce and ant-skid surface.

2. Rungs shall be uniformly spaced at 12 inches on center.

3. Rungs shall be designed to support a 1,200 pound vertical load applied at midspan.

4. Rungs shall be both mechanically attached and epoxy bonded to the side rails.

G. Fall prevention system and anti-climb guard shall be as specified in Section 05515, Ladders.

2.10 CONNECTIONS

A. All connections shall be non-corrosive, non-staining, and concealed where practicable, as detailed on the Drawings or specified herein.

B. Fiberglass fasteners shall be "Fibrebolt", as manufactured by Strongwell, Inc., or equal.

C. All metal fasteners shall be Type 316 stainless steel, except for sodium hypochlorite applications, Hastelloy C-276 shall be used unless noted otherwise.

D. Holes for bolts and screws shall be drilled.

E. Joints exposed to weather shall be formed to exclude water.

F. Design and installation of fiberglass items shall provide for expansion and contraction, prevent shearing of bolts, screws and other fastenings, and provide close fitting of sections.

2.11 STRUCTURAL SHAPES AND FLAT SHEETS

A. Shapes shall conform to sizes indicated on Drawings and shall be Extren 525 except for sodium hypochlorite applications where Extren 625 shall be used. Shapes shall be manufactured by Strongwell, Inc., or equal.

B. Metal bolted connections shall be made with stainless steel bolts except for sodium hypochlorite applications where Hastelloy C bolts shall be used. Bolts shall conform to Section 05050, Metal Fastening.

C. Adhesive bonded connections shall be made with a compatible epoxy adhesive following manufacturer's instructions.

2.12 FRP HANDRAIL

A. Fiberglass reinforced plastic (FRP) handrail system shall be designed by the Contractor to meet or exceed OSHA requirements with a minimum safety factor equal to 2, and shall be furnished and installed as shown on the Contract Drawings. All rails, posts, kick plates, base plates, fasteners, and necessary appurtenances for a complete and rigid installation shall be provided and installed per manufacturer's recommendations. Handrail systems shall be manufactured by Strongwell, Inc., Bristol, VA, R.W. Fowler Company, Atlantic Beach, FL, IMCO Reinforced Plastics, Inc., Moorestown, NJ, or equal.

B. The handrail system shall consist of pultruded fiberglass shapes manufactured with the following minimum properties:

| Properties | Test Method | Value |
|---|---|---|
| Tensile Stress | ASTM D638 | 30,000 psi |
| Tensile Modulus | ASTM D638 | $2.5 \times 10^6$ psi |
| Compressive Strength | ASTM D695 | 30,000 psi |
| Compressive Modulus | ASTM D695 | $2.5 \times 10^6$ psi |
| Flexural Stress | ASTM D790 | 30,000 psi |
| Flexural Modulus | ASTM D790 | $2.0 \times 10^6$ psi |
| Shear Stress | ASTM D2344 | 4,500 psi |
| Density | ASTM D792 | .070 lbs/in$^3$ |
| 24 hr. Water Absorption | ASTM D570 | 0.6% max |
| Coeff. of Thermal Expansion | ASTM D696 | $6 \times 10^6$ in/in/EF |
| Barcol Hardness | | 50 |

C. The handrail system shall have two (2) rails, unless otherwise noted on the Contract Drawings, with the top rail located 42 inches above the walking surface. Rails and posts shall be 2" square tubing with internal fittings for all connections. Kick plates shall be provided where required by OSHA. All rail and kick plate corner joints shall be mitered at a 45° angle and securely fastened to posts. Maximum horizontal spacing between posts shall be 4 feet. For stair rail, the top rail shall be not less than 34 inches nor more than 38 inches above the leading edge of the stair tread.

D. Handrails shall be erected with true horizontal and vertical alignment and shall be smooth and free of surface defects. All cut edges and holes shall be sealed with a compatible resin system.

## PART 3 -- EXECUTION

### 3.01 FABRICATION

A. All cut edges and holes shall be sealed with a compatible resin.

B. All FRP items shall conform to the dimensions indicated on the Drawings.

C. All fiberglass items described in this Section shall be supplied by a manufacturer that normally fabricates such items so that appearance and quality control are first class.

### 3.02 HANDLING, TRANSPORTING, AND STORING

A. All FRP items shall be properly packed, labeled and stored in accordance with Divisions 1 and 11, and where directed by the Engineer.

### 3.03 INSTALLATION

A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.

B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.

C. Weirs and baffles shall be installed in full accordance with the manufacturer's recommendations. Joints between weir plates and concrete and butting weir plates shall be watertight. The Contractor shall seal all weirs with caulk after weirs are set, checked for level, and are within specified tolerances.

- END OF SECTION -

SECTION 07100

WATERPROOFING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Waterproofing on the exterior sides of walls below grade as shown on the Drawings.

2. Crystalline waterproofing as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | ASTM D146 | Sampling and Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use in Waterproofing and Roofing |
| 2. | ASTM D412 | Tests for Rubber Properties in Tension |
| 3. | ASTM E96 | Tests for Water Vapor Transmission of Materials in Sheet Form |

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturers product literature, specification data sheets and installation instructions.

2. Samples of composite drainage panel and waterproofing.

3. Complete layout and installation drawings and schedules with clearly indicated dimensions.

4. Detail drawings showing all anchoring details and construction details at corners, penetrations and flashing.

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1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.

B. Store materials in dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have been damaged and remove from the job site.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. Grace Construction Products.

2. Mirafi Incorporated.

3. Polyguard Products.

2.02 PRODUCTS

A. Waterproofing Membrane: Self-adhering membrane consisting of a minimum 56 mils of rubberized asphalt laminated to a minimum 4 mils of polyethylene to form a minimum of 60 mil membrane. Provide a cold-applied membrane which requires no special adhesives or heating equipment.

B. Physical Properties

| PROPERTIES | TEST METHOD | RESULT |
|---|---|---|
| Pliability (@ -25 f) | ASTM D-146 | No Effect |
| Tensile Strength Membrane | ASTM D-412 | 250 psi min. |
| Tensile Strength Film | ASTM D-412 | 4000 psi min. |
| Elongation | ASTM D-412 | 300% min. |
| Puncture Resistance Membrane | ASTM E-154 | 40 lbs. min. |
| Puncture Resistance Film | ASTM D-781 | 250 in. oz. tear |
| Permeance | ASTM E-96 (B) | 0.1 max. grains/sf/hr/in.Hg |
| Water Absorption | ASTM D-570 | 0.2 max. (% by weight) |
| Adhesion to Concrete | ASTM D-903 | 5.0 lbs./in. width max. |

C. Primer: As recommended by manufacturer.

D. Mastic: As recommended by manufacturer. Use mastic to seal cut edge terminations.

2.03 COMPOSITE DRAINAGE PANEL

A. Composite drainage panel: Three dimensional, high impact, polystyrene core with a nonwoven filter fabric bonded to the core. Provide an polymeric sheet adhered to the flat side of the polystyrene core. Extend filter fabric beyond the edges to provide total filtering integrity of the drainage system.

B. Physical Properties

| PROPERTIES | TEST METHOD | RESULTS |
|---|---|---|
| Compressive Strength (Core) | ASTM D-1621 | 15,000 psf |
| Apparent Opening Size (Filter Fabric) | ASTM D-4751 | 100 United States Standard Sieve |
| Water Flow Rate (Filter Fabric) | ASTM D-4491 | 150 gpm/ft |
| Water Flow (Composite System) | ASTM D-4716 | 15 gpm/ft. width |

C. Composite System Requirements

1. Provide one inch flange on longitudinal edge.

2. Bond filter fabric to each dimple of polymeric core.

3. Extend filter fabric beyond toe edge of polymeric core to provide total filtering integrity of the drainage system.

4. System shall be approved for use over waterproofing membrane.

2.04 CRYSTALLINE WATERPROOFING

A. Crystalline Waterproofing: Concrete waterproofing material of the cementitious crystalline type that chemically and permanently fixes non-soluble crystalline growth throughout the capillary voids of the concrete. Apply at a rate of 2 lb./sq. yd. Apply second coat while first coat is still green. Crystalline waterproofing shall be as manufactured by Xypex Chemical Corporation, Vandex, HEY'DI K11 by Tamms, or equal.

PART 3 -- EXECUTION

3.01 EXAMINATION OF SURFACES

A. Examine all surfaces and installation of work done by other trades.

B. Coordinate all work under this Section with contiguous work of other trades.

3.02 APPLICATION

A. Install waterproofing membrane and composite drainage system in strict accordance with manufacturer's printed instructions and recommendations.

B. Where drainage piping is shown on Drawings, extend systems to allow for proper drainage.

C. Cover and seal all terminal edges. Cut systems and seal around penetrations.

D. Crystalline waterproofing shall be applied to "green" or existing concrete which has been thoroughly saturated with clean water. Prepare surfaces in strict accordance with manufacturer's recommendations and instructions. Mix and apply in accordance with manufacturer's literature.

E. Provide a written report from the Manufacturer's representative stating that the waterproofing membrane and composite drainage system were installed correctly.

- END OF SECTION -

# SECTION 07150

# DAMPPROOFING

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of work as shown on Drawings and specified herein.

B. Principal items of work include:

1. Dampproofing on exterior side of interior wythe of masonry cavity walls above grade.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 - Unit Masonry

### 1.03 REFERENCE SPECIFICATIONS CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. ASTM D 449 Standard Specification for Asphalt Used in Dampproofing and Waterproofing

### 1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the Section 01300, Submittals, submit the following:

1. Manufacturers product literature, specification data sheets and installation instructions.

### 1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, brand, type, grade, class and all other qualifying information.

B. Store materials in dry location to prevent damage or intrusion of foreign matter. Remove damaged materials from the job site.

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## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Subject with compliance with the Specifications provide products from one of the following:

1. Karnak Corp.

2. W.R. Meadows

3. Koch Materials Co.

2.02 MATERIALS

A. Asphalt Primer: Type recommended by manufacturer.

B. Dampproofing: Non-asbestos, fibrated mastic conforming to ASTM D-1227, Type II, Class 1, compatible with cavity wall insulation.

PART 3 -- EXECUTION

3.01 EXAMINATION OF SURFACES

A. Examine all surfaces and installation of work done by other trades.

3.02 APPLICATION

A. Prime surfaces with manufacturers recommended primer. Apply dampproofing at the rate of 6 gallons per 100 square feet.

B. Apply dampproofing to substrates to provide a complete moisture resistant coating.

3.03 PROTECTION

A. Protect building from damage resulting from spillage, dripping and dropping of materials. Repair work damaged during dampproofing operations.

B. Take precautions against fire and other hazards during delivery, storage and installation of flammable materials. Comply with local ordinances and fire regulations in the installation of hazardous materials.

3.04 CLEANING

A. Clean adjacent materials and finishes which have been soiled.

- END OF SECTION -

SECTION 07190

VAPOR BARRIER

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish labor, material, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Vapor barrier below structural slabs on grade.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

### 1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's data and installation instructions.

## PART 2 -- PRODUCTS

### 2.01 VAPOR BARRIER

A. Vapor Barrier: A reinforced laminate membrane with a minimum tensile strength of 75 lbs/in. in accordance with ASTM D-882, vapor transmission rating of 0.02 perms in accordance with E-96, and a puncture resistance of 25 lbs in accordance with ASTM D-4833.

B. Adhesive/Tape: Type approved by the Manufacturer of the vapor material.

C. Penetration sealing: Provide manufacturer’s recommended penetration seals at all pipe, conduit, and similar penetrations.

### 2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Viper Vapercheck 10 by Insulation Solutions, Inc.

2. Griffolyn Type-85, by Reef Industries, Inc.

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3. Or Equal

PART 3 -- EXECUTION

3.01 VAPOR BARRIER

A. Vapor barrier shall be placed on top of 4 inches minimum of compacted structural fill stone, free of debris and protrusions, as shown on the Drawings for structural slabs.

B. Lap edges 12 inches and seal with adhesive tape. Lay with seams perpendicular to and lapped in the direction of placement. Do not penetrate vapor barrier.

C. Protect from damage until concrete is placed. Punctures and tears in vapor barrier shall be repaired using patches of the material which overlaps puncture or tear a minimum of 12 inches; seal with tape or adhesive.

D. Penetrations through vapor barrier, such as pipe, drains, conduits and similar penetrations, shall be sealed in strict accordance with manufacturer's recommended instructions.

- END OF SECTION -

SECTION 07210

BUILDING INSULATION

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03300 - Cast-in-Place Concrete

B. Section 04200 - Unit Masonry

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | HH-I-526C | Insulation Board, Thermal (Mineral Fiber). |
| 2. | HH-I-1972/1 | Insulation Board, Thermal, Polyurethane or Polyisocyanurate, Faced with Aluminum Foil On one side. |
| 3. | TT-S-001657 | Sealing Compound Single Component, Butyl Rubber Based, Solvent Release Type (For Buildings and other Types of Construction). |
| 4. | ASTM C 578 | Specification for Preformed, Block Type Cellular Polystyrene Thermal Insulation |
| 5. | ASTM C 665 | Specification for Mineral fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing. |

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature, specifications, installation instructions, technical data, and general recommendations.

2. Samples of each type of insulation specified.

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1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in unopened, undamaged original packaging with bearing the manufacturer's name.

B. Store materials in clean, dry, protected areas. Do not leave materials exposed to the weather or sunlight, except to the extent necessary to perform the work.

C. Protect against ignition.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the requirements, provide products as manufactured by the following:

1. Manufacturers of Extruded Polystyrene Board Insulation

a. Amoco Foam Products Company

b. Dow Chemical U.S.A.

c. UC Industries

2. Manufacturers of Polyisocyanurate Foam Insulation

a. Apache Products Company.

b. Atlas Energy Products.

c. The Celotex Corporation.

3. Manufacturers of Sprayed Polyurethane Foam (Gap Sealant):

a. The Dow Company
b. Or approved equal

2.02 MATERIALS

A. Cavity Wall Insulation: Extruded polystyrene insulation boards meeting or exceeding the requirements of ASTM C578, Type IV, and with a "K" factor of 0.20 or less when tested in accordance with ASTM C 518. Provide insulation 1-1/2 inches thick unless otherwise shown.

B. Roof Insulation: Provide a minimum of 2" extruded polystyrene insulation. Provide a minimum of two staggered layers, unless otherwise indicated. Provide tapered insulation where roof structure does not slope. Roof insulation shall be approved by roofing manufacturer in accordance with the requirements of the roofing warranty. Roof insulation shall meet the requirements of a UL Class A and FM Class 1 roof. Insulation shall have an aged R-value of 5 per inch. Secure insulation as required by the roofing manufacturer to

achieve an FM 90 installation. Install ½" glass faced gypsum board where insulation is installed over metal deck.

C. Safing Insulation: Semi-rigid boards for use as fire stop. Materials shall conform to requirements of UL penetration systems. Safing material shall meet the requirements of ASTM E-136.

D. Adhesive and Fasteners: Type compatible with insulation, masonry, concrete, or other substrate and as recommended or produced by the insulation manufacturer.

E. Sealer and Tape: Type recommended by insulation manufacturer and having perm rating and fire resistance characteristics similar to that of the insulation.

F. Gap Sealant: General Purpose Type: single-component polyurethane sealant. Gun-applied and Straw-applied products, Thermal Value R3.5 per inch. Provide GREATSTUFF PRO™ Gaps & Cracks Insulating Foam Sealant as manufactured by The Dow Chemical Company or approved equal. Provide Substrate Cleaner as recommended by foam sealer manufacturer.

## PART 3 -- EXECUTION

### 3.01 GENERAL

A. Insulation shall be provided in walls, slabs and ceilings and where shown on Drawings.

### 3.02 INSTALLATION OF INSULATION

A. Install in accordance with the manufacturer's printed installation instructions to provide maximum sound and thermal benefits for material specified. Install to fill or cover voids. Cut neatly to snugly fit angles, corners and irregular areas and carefully wrapped around pipes, conduits, outlets, switches, beams, etc., to maintain continuity of insulation. Avoid gaps or bridges.

B. Cavity Wall Insulation

1. On vertical surfaces of masonry adhere to inner wythe of block.

2. Joints between insulation board units shall coincide with masonry joint reinforcing.

C. Roofing Insulation: Install roofing insulation in accordance with insulation and roofing manufacturer printed instructions and recommendations.

D. Safing Insulation: Install safing insulation in accordance with UL design requirements and in accordance with manufacturer's recommendations.

E. Gap Sealant: Seal all gaps at perimeter of walls and penetrations and openings. Install in strict accordance with manufacturer's recommendations.

3.03 ADJUSTMENT AND CLEANING

A. Adequately protect Work from damage resulting from subsequent construction operations. Replace damaged or soiled Work.

- END OF SECTION -

SECTION 07270

FIRESTOPPING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials and equipment required to complete the installation of troweled or gun applied firestopping as indicated on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 15 - Mechanical

B. Division 16 - Electrical

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | ASTM E84 | Test Method for Surface Burning Characteristics of Building Materials. |
| 2. | ASTM E119 | Method for Fire Tests of Building Construction and Materials. |
| 3. | ASTM E814 | Test Method of Fire Tests of Through- Penetration Firestops. |
| 4. | ASTM E 1966 | Standard Test Method for Five Resistive Joint Systems. |
| 5. | UL-01 | Building Materials Directory. |
| 6. | Ul-1479 | Fire Test of Through-Penetration Firestops |
| 7. | UL-2079 | Tests for Fire Resistance of Building Joint Systems. |

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Product data on characteristics, performance, and limitation criteria.

2. Manufacturer's installation instructions.

3. Certification that products meet or exceed requirements.

4. Detail Drawings.

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1.05 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E-814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. Engage an installer with a minimum of 5 years experience and who is certified, licensed, or otherwise qualified by firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.07 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. Hilti, Inc.

2. 3M Corp.

3. Specified Technologies, Inc.

### 2.02 MATERIALS

A. Provide firestopping materials of commercially manufactured products complying with the following minimum requirements and as listed in Underwriters Laboratories, Inc. -Building Materials Directory.

1. ASTM E84 or UL 723 with a flame spread of 25 or less; smoke development rating of 50 or less; fuel contribution of 50 or less.

2. Non-toxic and non-corrosive during each stage of application and during fire conditions.

3. Penetrations: ASTM E814 or UL 1479 with 2 hour ratings or as shown on Drawings.

4. Joints: UL 2079 2 hour rating or as shown on Drawings.

5. Non-combustible when tested in accordance with ASTM E136.

6. Materials shall impede the passage of smoke and gases.

B. Backing Material: Unfaced non-combustible mineral wool, or manufacturer pre-fabricated backer rod, as per Underwriters Laboratories, Inc. Building Materials Data.

C. Accessories: Collars, fasteners, straps, and other accessories shall be manufacturer's standard products approved for UL through penetrations.

## PART 3 -- EXECUTION

### 3.01 SURFACE PREPARATION

A. Perform preparation and cleaning procedures in compliance with manufacturer's instructions.

3.02 INSTALLATION

A. Install firestopping as shown on the Drawings, as specified, and as required by UL-system. Firestop the following:

1. Duct, conduit, and pipe penetrations through below-grade floors and time-rated partitions.

2. Penetrations of vertical shafts.

3. Gaps between fire rated partitions and structure above, or exterior walls.

B. Install firestopping in strict accordance with UL through-penetrations systems requirements.

C. Cure finished work as recommended by the manufacturer to avoid shrinkage cracks.

3.03 MIXING

A. Mix and prepare materials in compliance with the manufacturer's directions.

B. Store materials in tightly covered containers. Maintain containers used in storage, mixing, and application of firestopping in a clean condition, free of foreign materials and residue.

C. Mix materials to produce a uniform density and as required for application of the materials.

3.04 INSPECTION

A. Examine the substrates to receive firestopping and the conditions under which the work is to be performed and notify the Engineer in writing of any conditions detrimental to the proper and timely completion of the work and performance of the firestopping. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the material manufacturer and Engineer.

B. Commencement of firestopping work shall be interpreted as proof of acceptability of the substrates, by the applicator and the applicator's acceptance of responsibility for any failure of bond between installation of firestopping and substrate in any particular area.

C. Do not apply materials over incompatible steel primers, dirt, rust, grease, moisture or other conditions unacceptable according to the manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.06 ADJUSTMENT AND CLEANING

A. Upon completion of work, clean spattered surfaces. Remove spattered materials by methods of washing and scraping, using care not to scratch or otherwise damage finish surfaces. Clean with manufactures recommended solution.

B. Protect work of other trades, whether to be coated or not, against damage by the work. Correct damage by cleaning, repairing or replacing and recoating. Leave all work in undamaged condition.

C. Take precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of firestopping.

- END OF SECTION -

SECTION 07415

STANDING SEAM METAL ROOFING AND WALL PANELS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of work shown on Drawings and specified herein.

B. Work includes:

1. Standing seam metal roofing, wall panels, trim, flashing and accessories associated with a complete and weathertight roofing system and as indicated on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 07210 - Building Insulation

B. Section 07700 - Roof Specialties and Accessories

C. Section 07900 – Joint Fillers, Sealants and Caulking

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Drawings of proposed work, including fastener type and spacing, roof panels, support framing, flashing, snow retention system, and accessory details.

2. Manufacturer's product data, specifications and installation instructions.

3. Submit calculations signed by a professional engineer indicating loads, uplifts, spacing of clips, fasteners, snow retention system, and accessories. Calculations shall be project specific in accordance with ASCE 7.

4. Submit certification that installer is authorized by manufacturer.

5. Structural design data and calculations.

6. Drawing showing spacing of fasteners and supports.

7. Letter verifying that panels are factory roll formed.

8. Sample warranties.

9. Copy of 20-year Manufacturer’s warranty.

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1.04 DESIGN CRITERIA

A. Use the following standards and criteria where applicable in the structural design of the roof support system:

1. Kentucky Building Code

2. “Steel Construction Manual”, American Institute of Steel Construction

3. “Cold Formed Steel Design Manual”, American Iron and Steel Institute

4. ASCE 7 - Minimum Design Loads for Buildings and Other Structures

B. Design Loads

1. Design loads include live, snow, wind, earthquake and dead loads.

2. Loads and combination of loads shall be as prescribed and recommended in the standards and codes listed above.

3. Design roof to withstand 100 mph winds.

4. Thermal expansion and contraction expected for this location.

1.05 WARRANTY

A. Roof and Wall Panels

1. Exterior finish shall be warranted by the manufacturer for twenty years against blistering, peeling, cracking, flaking, checking and chipping.

2. Color change and chalking shall be warranted for twenty years. Color change shall not exceed 5 NBS units per ASTM D 224. Chalking shall be not less than a rating of 8 per ASTM D 659.

B. Weathertightness

1. Single Source manufacturer’s roof system warranty including roof panels, fascia, trim flashing, penetrations, and other materials integral to the roof system, against leaks for a period of twenty years.

2. No dollar limit.

C. Provide all materials required by roofing manufacturer to obtain specified warranty whether or not specifically indicated.

1.06 QUALITY ASSURANCE

A. Manufacturer shall have been regularly engaged in the fabrication of metal standing seam roof systems for at least ten years.

B. Installer shall be authorized by the Manufacturer as trained and qualified to erect the Manufacturer's product.

C. Conduct a preroofing conference with the following attendees; Contractor, metal-roofing Contractor, metal roofing systems manufacturer's representative, all sub-Contractors whose work penetrates the roof, the Owner and Engineer.

D. Metal roofing system manufacturer's representative will observe the installation of the roof system at the start of the project and observe a minimum of 10 squares of roofing installation, and as required by the manufacturer to ensure warranty provisions are adhered to. The manufacturer's representative will produce a report based on observations of the roofing system that indicates that the roofing system, trim, accessories have been installed in accordance with all requirements of the manufacturer. If any deficiencies in materials or installation are found during this inspection the deficiencies shall be corrected.

E. System shall be tested in accordance with UL 580 or ASTM E 1592.

## PART 2 -- PRODUCTS

### 2.01 BASIS OF DESIGN

A. The Garland Company, R MER SPAN

### 2.02 PRODUCTS

A. Standing Seam Roof Panels

1. Smooth finished 0.040 Aluminum sheets factory finished with two coat, baked-on full-strength (70% resin) fluorocarbon coating system. Color shall be selected by the Owner.

2. Panels shall be 16" or 18" wide by length required to cover roof to minimize end laps.

B. Roof System

1. Structural standing seam incorporating with continuous "T" batten and secured to concealed anchor clips allowing unlimited thermal movement, and of configurations that will prevent entrance or passage of water.

2. Roof system shall comply with UL90 classification.

3. Fastening system shall allow the roof covering to move independently of any differential thermal movement by the framing system.

4. Provide interlocking batten cap with a plant applied, and non-hardening sealant. Mechanically lock or crimp seams during installation.

5. Seal panel termination and perimeter flashing with sealant approved by manufacturer.

6. Provide metal closures matching roof profile at ridge, headwall, rake, jamb and hip conditions.

7. Panels length shall be full length from factory. Field formed panels will not be allowed.

8. Coordinate structural support locations for wall and roof panels. Provide additional structural support, if required by panel manufacturer to resist required design loads.

9. Roof and wall panels shall be furnished in continuous lengths from ridge to eave of top of wall to bottom of wall panel.

10. Seam height will be a minimum of 2-3/8".

C. Sub-framing System

1. Provide a minimum of 16 gauge galvanized steel cold formed framed sub-framing system.

D. Trim System

1. Design trim to provide for expected movement of roof panels due to thermal expansion.

2. Use manufacturer's standard trim pieces, except where field formed pieces are recommended by the manufacturer.

3. Use .032 or.040 Aluminum trim with factory finish to match roof panels.

4. Concealed fasteners shall be used to the greatest extent possible. Where exposed fasteners are used, they shall be installed neatly and aligned with other fasteners in straight rows and lines and finished to match roof panels.

E. Roof Accessories

1. Use EPDM roof jacks with aluminum sealing ring for openings 12 inches in diameter or less. Do not use roof jacks where ribs are altered.

2. Provide .032 or .040 gutters and downspouts with a 20 year factory applied fluorocarbon finish. Color shall match roof panels.

3. Snow Retention System: Provide clamps with stainless steel fasteners that mechanically attach to standing seams without penetrating the roof system. Snow retention system shall include cross members to retain snow with snow and ice clips. Snow retention system shall be specifically manufactured for profile of standing seam metal roofing. Snow retention system manufacturer shall design system for local conditions and provide multiple rows as required by the manufacturer's design to resist sliding snow. Snow retention system shall be approved for use by standing seam roofing system manufacturer and not void or limit warranty. Color to match standing seam roofing system and color warranty. Provide S-5 Colorguard by Metal Roof Innovations, Ltd., or SnoBar/ColorBar by SnoBlox-Snojax; or approved equal.

4. Underlayment: Provide underlayment over entire roof area. Underlayment shall be 40 mil self adhesive membrane. Underlayment may not be shown on drawings.

F. Fascia and Soffit Panels

1. Shall be interlocking flush panels with concealed fasteners. Panels shall be nominal 12” wide by 1” deep and of lengths required to complete work. Finish to match roof panels with 20 year warranty.

## PART 3 -- EXECUTION

### 3.01 INSPECTION

A. Manufacturer shall inspect conditions of structural system and work below. Verify that work is complete to a point where this work can commence and installation can be performed in accordance with the manufacturer's recommendations and instructions.

### 3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions and approved shop drawings.

B. Replace damaged or defective items.

- END OF SECTION -

SECTION 07540

SINGLE PLY MEMBRANE ROOFING (PVC)

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

B. Principal items of work include:

1. Preparation of roof deck to receive new roofing materials.

2. Application of insulation, and accessories.

3. Fully adhered roofing system with applied battens.

4. Fifteen year "Total Roofing System Warranty".

5. Removal and cleanup of excess materials and debris.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM Designations; Stipulated under PART 2 - PRODUCTS.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, submit the following:

1. Manufacturer's Data.

2. Manufacturer's Installation Instructions.

3. Total System Warranty.

4. Dimensioned shop drawings which shall include:

a. Outline of roof with roof size and elevations shown.

b. Profile details of flashing methods for penetrations.

c. Technical acceptance from Sarnafil.

5. Certification that all materials submitted are acceptable for warranty coverage indicated.

1.04 QUALITY ASSURANCE

A. The installer must be skilled and experienced and approved by roofing membrane manufacturer for type of roofing and associated work required, and equipped to perform workmanship in accordance with recognized standards.

B. Provide periodic inspections by an official manufacturer's technical representative on all roofing and flashing. Inspections to be made at the beginning of the job and a minimum of one more while the roofing and/or flashing work is in progress to insure workmanship is in accordance with the manufacturer's specifications.

1.05 CODE REQUIREMENTS

A. Installed system shall meet all State and local codes, approved and listed to meet the following: UL class A and FM 1-90.

B. Inform all personnel working on roof of fall protection requirements. Provide all necessary equipment and training for proper use to comply.

1.06 GUARANTEE

1. Furnish to the Owner a fifteen (15) year written Manufacturer's Warranty covering materials and workmanship for the entire "Roofing System", including repair and replacement of roofing components which are deemed faulty or in disrepair during the guarantee period. Such items in disrepair shall be repaired at no cost to the Owner. Cover both labor and materials necessary to effect watertightness, including that required to repair roof leaks caused by standing water, defective material or workmanship, without limit as to amount required to effect watertightness.

1.07 JOB CONDITIONS

A. Roofing products shall be installed in accordance with manufacturer’s recommended job conditions including environmental and physical.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer's unopened containers identified with name, type, grade, class and all other qualifying information, including UL and other specified insurance agency's labels.

B. Store materials in a dry location, in such manner as to prevent damage or intrusion of foreign matter. Conspicuously mark "Rejected" on materials which have once been wet or damaged and remove from the job site.

PART 2 -- PRODUCTS

2.01 MEMBRANE

A. Membrane shall conform to ASTM D4434-96 (or latest revision), "Standard for Polyvinyl Chloride Sheet Roofing". Classification: Type II, Grade I.

1. Sarnafil $_{6}$G410-15 feltback, 59 mil (1.5 mm), thermoplastic membrane with fiberglass reinforcement and a factory applied 9 oz geotextile felt backing.

B. Color of Membrane

1. White with a Solar Reflectance Index of 78 or greater.

2.02 FLASHING MATERIALS

A. Provide flashing approved for use with manufacturer's system warranty and in accordance with manufacturer's details.

2.03 INSULATION/OVERLAYMENT/RECOVER BOARD

A. Polyisocyanurate Insulation

A rigid isocyanurate foam insulation with black mat facers.

2.04 UNDERLAYMENTS

A. Provide Dens-Deck, a siliconized gypsum, fire-tested hard board with glass mat facers or equal.

2.05 VAPOR BARRIER

A. Two layers of bituminous vapor retarder as recommended by manufacturer.

2.06 ATTACHMENT COMPONENTS

A. Membrane and Underlayment Adhesive

1. Use manufacturer's recommended adhesives for materials and substrates to be fastened.

B. Insulation Board Adhesive

1. Type III hot asphalt or other adhesive recommended by manufacturer.

C. Fasteners

1. Use manufacturer's recommended fasteners for materials and substrates to be fastened.

2.07 MISCELLANEOUS ACCESSORIES

A. Provide all accessories recommended by the manufacturer to provide a watertight system.

2.08 RELATED MATERIALS

A. Wood Nailer

Treated wood nailers shall be installed at the perimeter of the entire roof and around such

other roof projections and penetrations as specified on Project Drawings. Thickness of nailers must match the insulation thickness to achieve a smooth transition. Wood nailers shall be treated and be #2 quality or better lumber. Creosote, CCA, or asphalt-treated wood is not acceptable. Wood nailers shall conform to Factory Mutual Loss Prevention Data Sheet 1-49. All wood shall have a maximum moisture content of 19% by weight on a dry-weight basis.

PART 3 -- EXECUTION

3.01 SURFACE PREPARATION

A. Installer shall notify Design/Builder, in writing, of defects in the substrate, and work shall not proceed until defects have been corrected. The starting of work implies the acceptance of such surfaces.

B. Construction work on the roof shall be complete before the roofing operations commence. The roof surfaces shall be clean, smooth, dry, and free from loose and foreign materials, dirt, oil, grease, and holes.

C. Surface joints (including walls and substrate) shall be 1/4-inch or less in width. Repair all joints wider than 1/4-inch with approved joint filler before proceeding with installation.

D. Vents and all other projections through the roof shall be secured in position before roofing is commenced.

3.02 INSTALLATION

A. Roofing shall be furnished and installed in compliance with U.L. Class "A" requirements. Manufacturer's instructions for the installation of such roofing system shall be strictly adhered to. All accessories necessary to complete the installation shall be provided.

B. The roofing shall be applied and finished in one area in a continuous operation. Care shall be taken to insure that water does not flow beneath any completed sections of roof. Loose edges of membrane shall be temporarily sealed with an approved night seal when the weather is threatening. When work is resumed, the sheet shall be pulled free before continuing installation.

C. Roofing and flashing installation at the junction of all parapet walls, curbs, and other roof openings shall be in accordance with the roof membrane manufacturer's standard details unless shown otherwise on the Drawings. Typical details of all actual roof conditions shall be submitted for approval prior to membrane installation.

3.03 WOOD NAILER INSTALLATION

A. Install continuous wood nailers at the perimeter of the entire roof and around roof projections and penetrations as shown on the Detail Drawings.

B. Nailers shall be anchored to resist a minimum force of 300 pounds per lineal foot in any direction. Individual nailer lengths shall not be less than 3 feet long. Nailer fastener spacing shall be at 12 inches on center. Fasteners shall be staggered 1/3 the nailer width and installed within 6 inches of each end. Two fasteners shall be installed at ends of nailer lengths. Nailer attachment shall meet this requirement and that of the current Factory

Mutual Loss Prevention Data Sheet 1-49.

C. Thickness shall be as required to match substrate or insulation height to allow a smooth transition.

3.04 VAPOR BARRIER INSTALLATION

A. Conduct moisture and adhesion tests in accordance with industry guidelines. If test requirements are met, prime the deck with asphalt primer, let dry and then adhere a base sheet with full mopping of Type III hot asphalt at a minimum rate of 25 lbs. per 100 square feet (1.2 kg/m²). Install a second ply in the same manner and then seal with an asphalt glaze coat. The base sheet and asphalt shall be installed in accordance with the manufacturer's instructions. The new insulation board shall be attached with additional Type III hot asphalt or by mechanical fasteners to the roof deck.

3.05 INSULATION INSTALLATION

A. Insulation shall be installed according to insulation manufacturer's instructions.

B. Insulation shall be neatly cut to fit around penetrations and projections.

C. Install tapered insulation in accordance with insulation manufacturer's shop drawings.

D. Do not install more insulation board than can be covered by the roofing membrane by the end of the day or the onset of inclement weather.

3.06 INSTALLATION OF SARNAFIL MEMBRANE

A. Inspect the surface of insulation prior to install of the roof membrane. The substrate shall be clean, dry, free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation boards shall be removed and replaced.

B. Apply adhesive and membrane in strict accordance to roofing manufacturer’s instructions and recommendations. Membrane shall be applied with no air pockets or wrinkles.

C. Mechanically fasten roof system 4’-0” from all roof edges along the entire perimeter using Sarnabar fastened 12” o.c. and with a welded cover strip.

3.07 HOT-AIR WELDING OF SEAM OVERLAPS

A. Welding: All seams shall be hot-air welded. Seam overlaps should be 3 inches (75 mm) wide when automatic machine-welding and 4 inches (100 mm) wide when hand-welding, except for certain details. All membrane to be welded shall be clean and dry. Welding shall be accomplished in strict accordance with manufacturer’s recommendations.

B. Quality Control of Welded Seams: Applicator shall check all welded seams for continuity using a rounded screwdriver. Visible evidence that welding is proceeding correctly is smoke during the welding operation, shiny membrane surfaces, and an uninterrupted flow of dark grey material from the underside of the top membrane. On-site evaluation of welded seams shall be made daily by the applicator including taking one inch (25 mm) wide cross-section samples of welded seams. Correct welds display failure from shearing of the membrane

prior to separation of the weld. Each test cut shall be patched by the Applicator at no extra cost to the Owner.

3.08 MEMBRANE FLASHINGS

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and Sarnafil. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing, the affected area shall be removed and replaced at no expense to the Owner. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution to ensure adhesive fumes are not drawn into the building. Apply flashing in strict accordance with manufacturer's instructions.

B. All flashings shall extend a minimum of 8 inches (0.2 m) above roofing level.

C. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded into place. No bitumen shall be in contact with the Sarnafil membrane.

3.09 METAL FLASHINGS

A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:

1. Factory Mutual Loss Prevention Data Sheet 1-49 (latest issue).

2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

B. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.

C. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.

D. Metal joints shall be watertight.

E. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood nailer a minimum of 1 inch (25 mm).

F. Hook strips shall extend past wood nailers over wall surfaces by 1½ inch (38 mm) minimum and shall be securely sealed from air entry.

3.10 COMPLETION

A. The Owner and roofing manufacturer's representative shall review the work at completion. All defects noted and non-compliances with the Specifications or the recommendations of roofing manufacturer shall be itemized in a punch list. These items must be corrected immediately by the Installer to the satisfaction of the Owner and roofing manufacturer. All work shall comply with warranty including necessary reviews prior to installation.

- END OF SECTION -

SECTION 07600

FLASHING AND SHEET METAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 04200 - Unit Masonry

B. Section 07415 – Standing Seam Metal Roofing and Wall Panels

C. Section 07700 – Roof Specialties and Accessories

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCES SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

| | | |
|---|---|---|
| 1. | OF-506C | Flux, Soldering, Paste, and Liquid |
| 2. | ASTM A176 | Stainless and Heat-Resisting Chromium Steel Plate, Sheet and Strip |
| 3. | ASTM B32 | Specifications for Solder Metal |
| 4. | ASTM D1187 | Test Method for Asphalt-Base Emulsions for use as Protective Coatings for Metal |
| 5. | "Architectural Sheet Metal Manual" by Sheet Metal and Air Conditioning Contractors National Association. | |

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's literature and installation instructions.

2. Complete layout and installation Drawings and schedules with clearly indicated dimensions.

3. Color samples.

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1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials in a clean dry protected area in such manner to preclude damage by denting, warping, or other distortion.

PART 2 -- MATERIALS

2.01 MATERIALS

A. Metal Flashing

1. Exposed to View: Provide prefinished 0.050 inches aluminum. Provide a full-strength Kynar 500 baked-on paint finish with a 20 year warranty.

2. Concealed from View: Provide a minimum of 22 ga. galvanized. steel sheet, stainless steel sheet, or mill-finished aluminum sheet.

B. Nails, screws, rivets, bolts and other fasteners: same material as sheet metal being attached. Nails shall be 18 gauge diameter shank, 1/4 inch diameter flat head, annular-thread, diamond point, long enough to penetrate backing by at least 1 inch. Nails shall be spaced 3 inches on center unless other spacing is indicated. Exposed fasteners shall match finish of metal being fastened.

C. Reglets shall be formed of 300 series stainless steel, minimum of 0.020 inch. Reglets shall be Model CO for insertion in concrete, MA-4 for insertion in masonry as manufactured by FRY Reglet Corporation. Corners shall be factory made, mitered and sealed. Furnish reglets to proper trade in sufficient time to be incorporated into the masonry or concrete work.

D. Plastic cement shall conform to ASTM D2822.

E. Sealants shall be silicone type.

F. Sealer tape shall be polyisobutylene tape specifically manufactured for setting flanges on bituminous roofing such as Morrison and Company CL-50.

PART 3 -- EXECUTION

3.01 FABRICATION

A. Shop fabricate Work to greatest extent possible. Comply with details shown and applicable requirements of SMACNA "Architectural Sheet Metal Manual" and other recognized industry standards. Fabricate for waterproof and weather resistant performance; with expansion provisions for running work, sufficient to permanently prevent leakage, and damage or deterioration of the work. Comply with material manufacturer's instructions and recommendations for forming material. Form exposed work without excessive oil-canning, buckling and tool marks, true to line and levels as indicated, with exposed edges folded back to form hems.

B. Roof penetration sheet metal work shall be provided and coordinated with the roofing system. The design and details shall conform to SMACNA "Architectural Sheet Metal Manual". Sheet metal items shall be built into roofing in strict accordance with the instructions of the roofing manufacturer.

- END OF SECTION -

SECTION 07700

ROOF SPECIALTIES AND ACCESSORIES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 06100 – Rough Carpentry

B. Section 07415 – Standing Seam Metal Roofing and Wall Panels

C. Section 07600 - Flashing and Sheet Metal

D. Section 07900 - Joint Fillers, Sealants and Caulking

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications Work shall conform to the applicable requirements of the following documents:

1. TT-P-641 (1) Primer Coating, Zinc Dust - Zinc Oxide (for galvanized surfaces

2. ASTM A 525 Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.

3. ASTM A 526 Specification for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.

4. ASTM B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

5. Sheet Metal and Air Conditioning Contractors National Association "Architectural Sheet Metal Manual" (ASMM).

6. The Aluminum Association "Specification for Aluminum Sheet Metal Work in Building Construction."

7. American Welding Society (AWS).

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Manufacturers literature and installation instructions.

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2. Samples, of each material listed.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in factory packed unopened cartons and crating bearing the manufacturer's labels.

B. Store materials in clean, dry protected area in such manner to preclude damage of any nature.

C. Handle all materials with proper care to avoid denting, marring, warping or other distortions during delivery, storage and handling.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. General: Provide roof specialties and accessories of design and construction compatible and approved for use with roofing manufacturer.

B. Fasteners: Provide all fasteners and attachments required to secure item to substrate and support loads required by applicable Building Code. Use only non-corrosive fasteners which are compatible with materials being joined.

C. Colors: Colors shall be selected by Owner.

2.02 GUTTERS AND DOWNSPOUTS

A. Material: 0.032 inch aluminum minimum.

B. Design: Manufacture gutters tapered and notched to provide telescoping joint. Design gutters and downspouts to accommodate expected thermal movement.

C. Supports and Fasteners: Provide manufacturers' standard straps, brackets and fasteners. Place supports and fasteners at 36 inches on center or as recommended by the manufacturer. Finish of supports, brackets and fasteners shall match gutter and downspout.

D. Accessories: Provide end caps, flashing, trim, and other items required for a complete installation.

E. Finish: Baked on Kynar, with 20 year warranty.

2.03 ROOF CURBS

A. Material: 18 gauge, G-90 galvanized steel, 12 inches high with mitered and continuous welded corners and seams, factory installed pressure treated wood nailers, and rigid fiberglass insulation.

B. Design: Provide roof curb units manufactured to fit manufactured roof panels. Provide integral water diverter. Design roof curb to support weight of equipment. Coordinate roof curb unit with roof panel manufacturer to ensure proper fit. Roof curb shall be approved for use by manufacturer.

C. Accessories: Provide interior liner, flashing, trim and other items required for a complete installation.

2.04 GRAVEL STOPS

A. Fascia: 0.050 inches extruded aluminum of 6063-T5 alloy.

B. Cant Dam: Commercial 24 gauge galvanized steel.

C. Concealed Splice Plates: 0.032 inches aluminum and finished to match fascia. Allow 1/4" at ball butt joints per twelve feet of length for expansion.

D. Accessories

1. Prefabricated Corners: Provide manufacturer's standard mitered and welded units.

2. Scuppers: Manufacturer's standard.

E. Finish: "Baked" on Kynar, with 20 year warranty.

PART 3 -- EXECUTION

3.01 INSTALLATION - GENERAL

A. Install roof accessories and specialties in accordance with the manufacturer's instructions. Provide a complete watertight and weatherproof installation. Install with provision for expansion and contraction.

3.02 DAMAGED MATERIAL

A. Repair or replace materials damaged during installation.

3.03 ADJUSTING AND CLEANING

A. Check levels and adjust as necessary after roofing and flashing is complete.

B. Protect materials from damage by other trades. Remove protective coatings at completion of project.

- END OF SECTION -

SECTION 07900

JOINT FILLERS, SEALANTS AND CAULKING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish labor, materials, equipment and appliances required for the complete execution of Work shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03250 - Concrete Accessories

B. Section 03290 - Joints in Concrete

C. Section 04200 - Masonry

D. Section 08800 - Glass and Glazing

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM C-920 Elastomeric Joint Sealants

2. ASTM D-1056 Flexible Cellular Materials - Sponge or Expanded Rubber

3. SWRI Sealant and Caulking Guide Specification

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 – Submittals, submit the following:

1. Manufacturers literature and installation instructions.

2. Color samples of each type of sealant.

1.05 QUALITY ASSURANCE

A. Applicator shall be a company specializing in the installation of sealants with a minimum of five years experience.

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1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in unopened labeled packages.

B. Store materials in location protected from freezing or damages.

C. Reject and remove from the site materials within broken or damaged packaging.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Sealants

1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C-920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation, or Sonolastic NP-2, Sonneborn, or DynaTrol II by Pecora Corporation.

2. Type 2: Single component polyurethane sealant meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Sikaflex 1A by Sika Corporation, DynaTrol 1-XL by Pecora Corporation, or Sonolastic NP-1 by BASF Construction Chemicals.

3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation, Sonolastic Omni Seal by BASF Construction Chemicals.

4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C-920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation, Sonolastic Omni Plus by BASF Construction Chemicals.

5. Type 5: Single component, acrylic latex meeting ASTM C-834. AC-20+ Silicone by Pecora Corporation, Sonneborn Sonolac by BASF Construction Chemicals.

6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal.

7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C-920, Type M, Grade NS, Class 25 such as Deck-O-Seal by W.R. Meadows, Tammsflex by DuraJoint Concrete Accessories, or Synthacalk GC2+ by Pecora Corporation.

8. Type 8: Nonsag, Multi Component, traffic grade polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation, Sonolastic Ultra by BASF Construction Chemicals.

B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.

C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 2.00 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.

D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.

E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.

F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 -- EXECUTION

3.01 QUALITY CONTROL

A. Coordinate work with details shown on approved shop drawings prepared by other trades.

B. Verify conditions in the field.

C. Schedule work to follow closely the installation of other trades.

D. Apply sealants and related items in temperatures and dry conditions recommended by the manufacturers.

E. Do not paint sealant, unless recommended by sealant and paint manufacturer.

3.02 PREPARATION

A. Protect finished surfaces adjoining by using masking tape or other suitable materials.

B. Clean and prime joints before starting any caulking or sealing work.

C. Thoroughly clean joints and spaces of mortar and other foreign materials. Cleaning agent shall be Xylol or similar non-contaminating solvent to remove any film from metal surfaces. Masonry or concrete surfaces shall be brushed or air jet cleaned.

D. Joint Requirements

1. All joints and spaces to be sealed in exterior work shall be less than 1/2 inch deep and not less than 1/4 inch wide. If joints in masonry are less than that specified herein, the mortar shall be cut out to the required width and depth. All joints and spaces to receive sealant shall be completely prepared and thoroughly dry before installation of sealant.

2. Unless otherwise specified, joints and spaces which are open to a depth of 1/2 inch or greater shall be solidly filled with back-up material to within 1/4 inch of the surface. Back-up material shall be packed tightly and made continuous throughout the length of the joints. Bond breaker shall be applied as required. If joints are less than 1/4 inch deep, the back-up material may be omitted, a bond breaker substituted and the joint completely filled with sealant. The back-up material shall not project beyond the 1/4 inch depth of the open space in any joint. The following

width-to-depth ratio table shall be adhered to, unless otherwise recommended by manufacturer.

| Joint Width | Sealant Depth | |
|---|---|---|
| | Minimum | Maximum |
| ¼ inch | 1/4 inch | 1/4 inch |
| Over 1/4 inch to 1/2 inch | 1/4 inch | Equal to width |
| Over 1/2 inch to 1 inch | 1/2 inch | Equal to width |
| Over 1 inch to 2 inch | 1/2 inch | 1/2 of width |

3.03 APPLICATION

A. Exercise care before, during, and after installation so as not to damage any material by tearing or puncturing. All finished work shall be approved before covering with any other material or construction.

B. Apply sealant by an approved type of gun except where the use of a gun is not practicable, suitable hand tools shall be used. Avoid applying the compound to any surface outside of the joints or spaces to be sealed. Mask areas where required to prevent overlapping of sealant.

C. All joints shall be waterproof and weathertight.

D. Point sealed joints to make a slightly concave joint, the edges of which are flush with the surrounding surfaces. Exposed joints in the interior side of the door and other frames shall be neatly pointed flush or to match adjacent jointing work.

E. Adjacent materials which have been soiled shall be cleaned immediately and the work left in neat and clean condition.

F. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise.

3.04 ADJUSTMENT AND CLEANING

A. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.

B. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Engineer.

3.05 SCHEDULE

**Schedule of Sealants**

| **Application** | **Sealant** | **Color** |
|---|---|---|
| Vertical and horizontal expansion and construction joints in concrete structures unless noted otherwise herein or on Drawings. | Type 1 | To closely match adjacent surfaces or mortar and as selected by the Owner. |
| Vertical and horizontal joints bordered on both sides by masonry, precast concrete, natural | Type 2 | To closely match adjacent surfaces or mortar and as |

| Application | Sealant | Color |
|---|---|---|
| stone or other porous building material, unless noted otherwise herein or on Drawings. | | selected by the Owner. |
| Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material. | Type 3 | To closely match adjacent surfaces and as selected by the Owner. |
| Masonry expansion and control joints less than 1¼" wide. | Type 2 | To closely match adjacent surfaces and as selected by the Owner. |
| Masonry expansion and control joints equal or greater than 1¼ inches wide and not to exceed 2". | Type 1 | To closely match adjacent surfaces and as selected by the Owner. |
| Interior – wood trim and finish joints. | Type 5 | Color to be selected by Owner |
| Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes. See Note 1. | Type 4 | To closely match adjacent surfaces and as selected by the Owner. |
| Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. See Note 2. | Type 2 OR Type 3 | To closely match adjacent surfaces and as selected by the Owner. |
| Below thresholds. | Type 6 | Manufacturer's standard |
| Submerged in liquids. See Note 4. | Type 1 | Manufacturer's standard |
| Submerged in liquids with high concentration of chlorine (> 2 ppm). | Type 7 | Manufacturer's standard |
| Horizontal Joints exposed to vehicular or pedestrian traffic. | Type 8 | To closely match adjacent surfaces. |
| Other joints indicated on the drawings or customarily sealed but not listed. | Type recommended by manufacturer | To closely match adjacent surfaces and as selected by the Owner. |

Note 1. Sealant for Laboratory Countertop shall be as recommended by countertop manufacturer.

Note 2. Provide UL approved sealants for penetrations thru fire-rated walls and as specified in Section 07270.

Note 3. Sealants which will come in contact with potable water shall meet the requirements of NSF 61.

Note 4. Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

- END OF SECTION -

SECTION 08120

ALUMINUM DOORS AND FRAMES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install all flush aluminum doors, frames, and related items, complete and operable, including all finish hardware and appurtenant work, all in accordance with the requirements of the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements and applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of this Section

1. Architectural Aluminum Manufacturers Association (AAMA) Specifications 2GD-A2HP.

2. National Association of Architectural Metal Manufacturers (NAAMM).

3. Windload test in accordance with ASTM E 330.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Shop drawings indicating details of construction, and connections.

2. Schedules showing sizes, types, finishes, locations, assembly methods, hardware and building location.

3. Manufacturer's specifications and installation instructions.

4. Certification that doors meet wind design criteria.

1.04 DELIVERY, STORAGE AND HANDLING

A. Materials shall be boxed or crated and protected prior to shipment from the factory. Protection shall be arranged to protect all hardware which may be attached.

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PART 2 -- PRODUCTS

2.01 ALUMINUM DOORS

A. Provide doors designed and manufactured by Cline, Kawneer, Special Lite, or approved equal.

B. Design doors to resist 20 psf wind load.

C. Materials of construction:

1. Standard Face Skins: Smooth, aluminum sheets of 5005-H14 alloy.

2. Skin: Minimum 0.024 inch thick, with a minimum tensile strength off 22,000 psi.

3. Core: phenolic-resin impregnated 99# kraft honeycomb.

4. Internal Reinforcing Members: Extruded aluminum alloy 6063-T5, minimum wall thickness 0.125 inch.

5. Edge Reinforcing Members: Extruded aluminum alloy 6063-T5, minimum wall thickness 0.250 inch.

6. Shock Plate: 1/8 inch oil-tempered hardboard.

7. Fasteners: Non-corrosive and as recommended by manufacturer.

8. Sealants: Non-staining and as recommended by manufacturer.

D. Hardware shall be of type recommended and designed for use with door and meet the following requirements:

1. Doors shall be swinging type, with mortise hardware. Cylinder shall be coordinated with Section 08710 - Finish Hardware. Provide weatherstripping at head, jamb and sill.

E. Louvers: 6063-T5 extruded aluminum alloy and 0.062 thickness. Louver blades shall be inverted.

1. Provide blank off panel full height and width of louver.

2.02 ALUMINUM FRAMES

A. Aluminum frames shall be extruded from 6063-T5 aluminum alloy, with a minimum wall thickness of .125 inches. Frames shall be designed by the manufacturer to accommodate door and to meet wind load requirements.

B. Adequately reinforce frame to receive hardware. Reinforcements shall be 6061-T6 aluminum and not less than 1/4 inch thick.

2.03 ANCHORS

A. Jamb anchors in unit shall be as recommended by manufacturer. Space anchors maximum of 24 inches on center.

2.04 FINISH

A. Doors and Frames: High performance organic coating Kynar/Polyvinylidene Fluoride (PVDF); AAMA 605.2.

B. Color: To be selected by Owner.

PART 3 -- EXECUTION

3.01 GENERAL

A. Workmanship and installation shall be in accordance with referenced standards. Field dimensions, conditions, and coordination with adjoining work shall be verified prior to fabrication.

3.02 INSTALLATION

A. General: The doors shall be securely anchored in a straight, plumb, and level condition without distortion of frame or panel components and in strict accordance with the manufacturer's published installation details and instructions.

B. Door Operation: Door shall operate freely, smoothly and quietly. Doors shall have a 3/32 inch head and jamb clearances with 1/32 inch tolerance.

- END OF SECTION -

# SECTION 08400

# ALUMINUM STOREFRONT

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENTS

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on the Drawings and specified herein.

### 1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturer's product data.

2. Test reports confirming compliance with specifications.

3. Complete shop drawings showing elevations, construction details, anchorage, joining, and sealing. Drawings shall be to scale and dimensions represent actual field conditions. Details shall include relationship with adjacent surfaces.

4. Samples of frame, corner section, fasteners and color chart.

### 1.03 SHIPPING, HANDLING AND STORAGE

A. Deliver material in manufacturer's original sealed containers.

B. Store materials in such a way as to prevent damage. Materials which are damaged, including warping, scratches, dents, etc shall be removed from the site.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. The following manufacturers are approved for use.

1. Kawneer Company Inc.

2. EFCO Corporation

3. Vistawall Architectural Products

### 2.02 MATERIALS

A. Aluminum: Extruded 6063-T5 or T6 alloy and temper.

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B. Glass: In accordance with Section 08800 - Glass and Glazing.

C. Fasteners: Stainless Steel or Aluminum.

D. Thermal Break: Poured in place polyurethane. Non-structural thermal barriers will not be acceptable.

E. Dissimilar Metals: Isolate as recommended by manufacturer.

2.03 PERFORMANCE CRITERIA

| | | | |
|---|---|---|---|
| A. | Air Infiltration | ASTM E283 | 0.06 CFM/sq ft max |
| B. | Water Infiltration | ASTM E331 | No water at 8 psf |

C. Maximum deflection shall be 1/175 of the span under a 40 psf windload.

2.04 FABRICATION

A. General

1. Aluminum frame extrusions shall have a minimum wall thickness of 0.080". Door sections shall have a .125" wall thickness.

2. All exposed work shall be matched to produce continuity a flush design between adjacent surfaces. Exposed raw edges will not be acceptable.

B. Frame

1. Depth shall not be less than 4.5".

2. Face dimension shall not be less than 2".

3. Frame components shall be screw spline construction.

C. Entrance Doors

1. Door depth shall be not less than 2".

2. Door stiles and rails shall have hairline joints at corners. Corner construction shall be mortise and tenon for physical interlock between rails and stiles.

3. Interior corners shall be joined by heavy concealed reinforcement brackets with screws and filet welded.

4. Doors shall have adjusting mechanism in top rail to provide for minor clearance adjustments.

5. Weatherstripping shall be wool pile.

6. Doors shall have a medium stile.

D. Glazing

1. Units shall be dry glazed with EPDM gasket on interior and exterior.

E. Door Hardware

1. Hinging shall be heavy duty pivot set. Size and number as recommended by manufacturer for heavy service.

2. Dead bolt with 1 3/8" throw and cylinder in accordance with Section 08710 - Door Hardware.

3. Flush bolts on inactive door.

3. Single acting concealed overhead closer.

4. Push/pull hardware shall be ADA compliant.

5. Aluminum threshold.

6. Weatherstripping.

2.05 FINISH

A. Finish of all exposed areas of storefront and components with a Kynar 500 coating. Color shall be selected by Owner.

PART 3 -- EXECUTION

3.01 INSPECTION

A. Verify that openings are of proper size and plumb, level, and in proper location and alignment. Notify the Engineer of any variances. Do not begin work until all unacceptable conditions are corrected.

3.02 INSTALLATION

A. Use only skilled tradesmen.

B. Storefront system shall be erected plumb and true, in proper alignment and relation to established lines and grades.

C. Entrance doors shall be securely anchored in place to a straight, plumb and level condition. Weatherstripping contact and hardware operation shall be checked and adjusted for proper operation and performance.

D. Apply sealing materials to provide a weather tight installation.

3.03 ANCHORAGE

A. Adequately anchor to maintain positions permanently when subject to normal thermal movement, building movement and specified windload.

3.04 PROTECTION AND CLEANING

A. Protect materials and finish from damage from construction activities and harmful substances. When performing final cleaning remove all protective devices and clean in accordance with the manufacturer's recommendation.

- END OF SECTION -

SECTION 08710

FINISH HARDWARE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 08120 - Aluminum Doors and Frames

B. Section 08400 – Aluminum Storefront

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:

1. ANSI/BHMA 156

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Manufacturers data for each item of hardware. Include installation and maintenance instructions.

2. Furnish templates to fabricators of other work which is to receive hardware.

3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules and similar information has been completed and accepted.

4. Prepare a keying schedule in consultation with the Owner.

1.05 QUALITY ASSURANCE

A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.

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B. Replace any item of finish hardware which cannot be installed or will not function properly.

C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.

D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.

E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

1.06 DELIVERY, STORAGE AND HANDLING

A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.

B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.

C. Provide secure storage area for hardware.

PART 2 -- PRODUCTS

2.01 MATERIALS AND FABRICATION

A. Hand of Door

1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.

B. Manufacturer's Name Plate

1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.

C. Base Metals

1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.

D. Fasteners

1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for

self tapping sheet metal screws, except as specifically indicated.

2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.

3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion of deterioration of finish hardware, base material or fastener.

E. Tools for Maintenance

1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builders hardware.

F. Hardware Finishes

1. Stainless steel, US32D unless otherwise noted.

2. Closers shall have a USP finish unless otherwise noted.

G. Field Checks

1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

2.02 DESCRIPTION OF PRODUCTS

A. Hinges

1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.

2. Sizes and weights of hinges:

a. Doors up to 36 inches - 4-1/2 inches regular weight.

b. Doors 36 inches to 40 inches - 5 inches regular weight.

c. Doors 40 inches to 48 inches - 5 inches heavy weight.

3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.

4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware

B. Locksets and Latchsets

1. Stainless steel, heavy-duty mortise type conforming to ANSI A156.13 Series 1000, Grade 1.

2. Wrought steel box strikes.

3. Stainless steel deadbolt with 1" throw approval.

4. 2 3/4 inch back set, 3/4 inch throw, two-piece anti-friction latchbolt.

5. Non-ferrous critical internal parts.

6. Cylinders shall be manufactured to conform to grand master key program.

7. Trim Design: LWM or GRM by Corbin\Russwin trim design by listed manufacturer. Provide LWM (lever) design in administration areas, provide GRM (knob) design in plant areas, unless otherwise indicated.

8. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage

C. Keys and Keying

1. Provide construction keyed, removable core master key system as directed by the Owner.

2. Furnish ten core removal keys and a quantity of master keys as directed by the Owner, not to exceed ten each per group. Furnish a minimum of 15 change keys per cylinder.

3. Furnish cylinders with six pin cores.

4. Provide a key schedule showing all key numbers and spaces to which each permits entry. The schedule and key cabinet, along with key gathering envelopes containing keys for each lock endorsed with lock number and space designation, shall be turned over to the Owner. Install keys with proper tags in the key cabinet. Establish a construction master key, and apply to locks and cylinders, except for closets, within major spaces. Locks for closets shall be shipped unlocked and the keys delivered to the Owner with the balance of the keys.

5. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage

D. Panic Hardware

1. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction.

2. ANSI A156.3, Grade 1.

3. Exterior trim to closely match locksets.

4. Single/active doors: mortise type.

5. Double doors: concealed vericle rod.

6. ANSI Function 08.

7. Acceptable manufacturer's: Von-Duprin, Adams Rite Manufacturing Company, Corbin/Russwin

E. Closers

1. Cast iron case with seamless one-piece forged steel spring tub.

2. Heavy duty forged steel arm.

3. Non-sized fully adjustable from size 1-6.

4. Backcheck intensity and location valves.

5. Delayed action closing.

6. Full metal cover.

7. Mechanical hold open device, except at fire rated doors.

8. ANSI 156.4, Grade 1.

9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.

10. Provide mounting brackets, and fasteners required for proper attachment.

11. Provide closers at fire rated doors.

12. Acceptable manufacturers: Corbin/Russwin, LCN, Norton

F. Overhead Door Holder

1. Heavy duty bronze, surface mounted with positive grip holder.

2. Track: extruded bronze.

3. Degree of opening: 85 - 110.

4. Finish: Satin Chrome Plated.

5. Acceptable manufacturers: Corbin/Russwin, Glynn-Johnson, Norton.

G. Door Stops and Bumpers

1. Finish: Satin chrome plated.

2. Floor mounted door stops.

a. Acceptable manufacturers and products: H.B. Ives 444, Hager Hardware Model 267F, and Glynn-Johnson Model FB36.

3. Wall bumpers

   a. Acceptable manufacturers and products: H.B. Ives Model 407, Hagar Hardware Model 234W, and Glynn-Johnson Model 60C.

H. Flush Bolts

1. U.L. listed.

2. Forged brass construction, 1/2" diameter flattened bolt tip, 12" long rod.

3. Fit standard ANSI door preparation.

4. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

I. Kickplates

1. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.

2. Acceptable manufacturers: H.B. Ives, Hagar Hardware, and Builders Brass Works.

J. Silencers

1. Rubber silencers: 3 for each single door and 2 for each double doors.

2. Acceptable manufacturers and products: Glynn-Johnson Models 64 or 65, Hager Hardware Models 308D or 307D, H.B. Ives Models 20 or 21.

K. Thresholds

1. Extruded aluminum saddle type with stainless steel fasteners. Six inches wide or as shown on drawings.

2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, and Zero International.

L. Door Bottom Seal

1. Extruded aluminum with neoprene seal.

2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96.

M. Weatherstripping

1. Extruded aluminum with neoprene seal.

2. U.L. Labeled.

3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328.

N. Electric Strike

1. 24 Volt, non handed unit designed to accommodate lockset specified. Unit shall be constructed from stainless steel. Unit shall meet BHMA standard 501, Grade 1 and UL rated for burglary resistance. Provide power supply with 24 V output and housed in a NEMA1 enclosure.

O. Power transfer shall be EPT type by Rixson or approved equal.

## PART 3 -- EXECUTION

### 3.01 GENERAL

A. Templates

1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

### 3.02 INSTALLATION

A. Install hardware in a manner which will eliminate cracks on surfaces.

B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, except as otherwise indicated or required to comply with governing regulations.

C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.

D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.

E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.

F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.

H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

3.03 ADJUST AND CLEAN

A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.

B. Final Adjustment

1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.

C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.04 HARDWARE SETS

A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Provide hardware required to meet Code requirements. Consult Drawings for set number required. Coordinate power supply, door switch, card reader, request to exit, and electric strike with security contractor.

B. Hardware shall be as follows (See door schedule for additional notes):

**Hardware Sets**

1. Hinges
   Electric Transfer
   Entrance Lockset (outside lever rigid)
   Electric Strike
   Overhead Door Closer Holder (active leaf)
   Flush Bolts (inactive leaf)
   Kickplate
   Threshold
   Door Bottom Seal
   Weatherstripping
   Astragal w/Weatherstripping

2. Hinges
   Entrance Lockset (Outside lever rigid)
   Electric Strike
   Door Closer
   Kickplate
   Threshold
   Door Bottom Seal
   Weatherstripping

3. Hinges
   Passage Latchset
   Kickplate
   Silencers
   Door Bumpers

4. Hinges
   Store Room
   Overhead Door Stop
   Kickplate
   Wallbumper
   Silencers

- END OF SECTION -

SECTION 08800

GLASS AND GLAZING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 08120 – Aluminum Doors and Frames

B. Section 08400 – Aluminum Storefront

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the requirements of these specifications the Work shall conform to the applicable requirements of the following documents:

1. CPSC 16 CFR1201 "Safety Standard for Architectural Glazing Materials."

2. ANSI Z97.1 "Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings."

3. North American Glazing Association "Glazing Manual."

4. Underwriters' Laboratories "Building Materials Directory."

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Sample of each type of glass and color chart.

2. Complete layout and installation drawings and schedules with clearly marked dimensions.

3. Manufacturer's technical descriptions and reports for glass and glazing.

1.05 JOB CONDITIONS

A. Check openings to verify that frames are plumb and true, square and secure.

B. Take field dimensions for cutting glass and fabricating units.

C. Do not install glazing when ambient temperature is less than 50 degrees F.

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1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in the manufacturer's original unopened labeled containers, clearly marked with their name and brand. Transport large panes of glass in vertical position with spacers to prevent contact between panes and edges.

B. Store glass in a dry, well ventilated location at a constant temperature, maintained above dew point. Handling shall be kept to a minimum. Protect glass from soiling, condensation or moisture of any kind.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products manufactured by one of the following:

1. PPG Industries

2. Libby - Owens - Ford

3. Cardinal IG

2.02 MATERIALS

A. Primary glass shall meet the requirements of ASTM C1036-90. Heat treated glass shall meet the requirements of ASTM C1048-90.

B. Tempered glass shall be plate or float glass tempered by a special heat process and 1/4-inch thick or as noted on Drawings. Tempered glass shall meet the requirements of ANSI Z97.1 and Consumer Product Safety Commission 16 CFR 1201. Tempered glass shall be used for all applications, unless otherwise noted.

C. Insulating glass shall be preassembled units of glass enclosing a hermetically sealed dehydrated air space and certified through the Insulating Glass Certification Council (IGCC) in accordance with ASTM E-773, E-774. Glass shall be made from tempered glass, or heat-strengthened glass where recommended by manufacturer for application indicated. The unit shall consist of a tinted 1/4" thick exterior light, 1/2" air space and 1/4" thick clear interior light. Sealing system shall consist of metal spacer with bent or soldered corners, butyl primary and silicone secondary seal. Desiccant shall be manufacturer's standard. Exterior pane shall be tinted and color shall be selected by the Owner from manufacturer's full range of colors. Exterior glass shall be insulated.

D. Glazing materials shall be a resilient, non-hardening glazing compound of either a polysulfide or a silicone type. Materials shall not contain any solvents and shall be 100% solids. Oil base putty shall not be used. Glazing compounds shall not be thinned with chlorinated solvents or benzene related compounds. Glazing tape may be used where, and as, recommended by the manufacturer. The color of all exposed glazing materials shall harmonize with the window units.

G. Setting blocks and spacer shims shall be a non-staining material as recommended by the glass manufacturer.

## PART 3 -- EXECUTION

### 3.01 GENERAL

A. Determine glass sizes by measuring the frames to receive the glass at the site. Comply with the manufacturer's specified tolerances for each type of glass including cutting tolerance, minimum edge clearance, minimum face clearance, and cover on glass.

B. The edges of all tempered and insulating glass shall be protected from damage and edges shall not be modified in any way after the glass leaves the factory. Nipping of any glass to reduce size shall not be permitted.

C. Deliver glass with manufacturer's labels showing type, thickness and quality of material (and U.L. label as required). These labels shall not be removed until the glass is set and final approval has been secured.

### 3.02 INSTALLATION

A. Sheet glass shall be cut and set with waves running horizontally.

B. All glass shall be set in such manner as to avoid possibility of breakage.

C. Rabbets shall be thoroughly cleaned and shall have been prime coated before glass is set.

D. Glass shall be well bedded and back glazed and all surplus compound and markings shall be carefully removed from doors, sash and adjoining work, while still fresh. Compound shall be finished in true, even lines, neatly and smooth faced. Set glass in strict accordance with the manufacturer's printed directions.

E. All glass when set and glazed shall be free from rattle and be watertight.

F. Glazing molds shall be removed and replaced in their correct locations in such a manner as not to mar molding or the screws securing same.

G. Install fire rated glass in strict accordance with manufacturer’s requirements to meet five rated assembly shown on Drawings.

### 3.03 PROTECTION AND CLEANING

A. Before and after installation, all work shall be properly protected against damage.

B. On completion and prior to turning the project over to the Owner, all metal work and glass shall be cleaned and left in perfect condition. Glass shall be washed outside and inside.

- END OF SECTION -

SECTION 09900

PAINTING

PART 1 -- GENERAL

1.01 RELATED WORK

A. Section 15030 - Piping and Equipment Identification Systems

1.02 QUALITY ASSURANCE

A. Required Experience and Workmanship

1. All cleaning and painting work covered by this Section shall be performed by a firm having at least five (5) years successful experience in the painting field, and shall have completed at least fifteen (15) projects of similar content and design.

2. All work shall be in accordance with the requirements hereinafter specified and the applicable requirements of the latest edition of standards provided by SSPC: The Society for Protective Coatings, 40 24th Street, Sixth Floor, Pittsburgh, PA, 15222 and the American Water Works Association (AWWA) 6666 W. Quincy Avenue, Denver, CO 80235.

B. Product Labeling

Labels to include:

1. Manufacturer's name

2. Type of paint

3. Manufacturer's stock and batch number

4. Color

5. Instructions for reducing, where applicable

C. Sampling of Materials

1. Obtain test samples from material stored at project site or source of supply.

2. Select samples at random from sealed containers.

1.03 SUBMITTALS

A. Product Data

1. Provide written description and catalog cuts describing each coating in the system. Information shall include; product delivery, storage, handling, application

and curing instructions and limitations. Include technical data sheets to substantiate compliance with specifications.

B. Certification

1. Provide Manufacturers certification that the coatings proposed meet the specifications and are suitable for the intended use.

C. Containment

1. Submit with Bid a narrative description and sketch of the proposed containment system, if required, presenting the basic containment concept, materials of construction and method of support.

D. Submit LEED Documentation in accordance with Specification Section 01811 and provide at a minimum the following:

1. Low-Emitting Materials — Paints and Coatings

a. Provide specific VOC data for each paint and coating.

b. Certify that architectural primers, paints, and coatings materials meet the minimum VOC limits established by Green Seal Standard GS-11.

c. Certify that anti-corrosive and anti-rust primers, paints, and coatings materials meet the minimum VOC limits established by Green Seal Standard GS-03.

d. Documentation and summary table in accordance with EQ Credit 4.2. See Specification Section 01811 – LEED Documentation Requirements.

1.04 PRODUCTS DELIVERY AND STORAGE

A. Delivery and Storage of Materials

1. All paints and solvents shall be delivered directly from the manufacturer to the site in new factory sealed containers clearly labeled showing the type of paint or coating and batch numbers. Only new paint purchased specifically for the Work shall be used. Leftover paints from previous jobs are not allowed.

2. Store only acceptable materials purchased for this project.

3. Store in suitable and secure locations.

4. Restrict storage to paint materials and related equipment.

5. Comply with manufacturer’s storage requirements.

1.05 JOB CONDITIONS

A. Environmental Regulations

1. Volatile Organic Compounds (VOC's) - VOC ratings (pounds per gallon (PPG) and grams per liter (GPL)). Verify that each coating to be used complies with Laws, Regulations, and LEED Requirements. Thinning of coatings in excess of the manufacturer's recommendation is not permitted.

2. Contact With Water - All surfaces to be painted that make contact with potable water or water or residuals involved in the treatment process, shall meet the ANSI/NSF 61 Standards for Potable Water Contact. Verify coatings to be used meet the ANSI/NSF 61 Standards for Potable Water Contact.

3. Safety Requirements - Comply with all Laws and Regulations having jurisdiction, SSPC-PA Guide 3 requirements, and the recommendations or requirements of paint and abrasive manufacturers. Should vents, holes, rigging attachments, or other modification, cutting, or welding be required on permanent structures in order to meet safety standards, submit written details and sketches to Engineer prior to performing Work. Engineer will review to verify that existing structures will not compromise relative to their intended permanent use.

4. Emissions - Comply with Laws and Regulations concerning the emission of solid, particulate or gaseous matter as a result of cleaning, painting or performance of other Work.

5. Waste Classification - Satisfy Laws and Regulations pertaining to the classification and disposal of waste. Waste to include abrasive blasting residuals, paint containers, unused paints and thinners, solvents and other materials to be disposed as a result of performing the Work.

6. Responsibility - Comply with Laws and Regulations without supervision by the Engineer, Engineer’s Consultant, Resident Project Representative, Owner or any party they may be responsible for.

B. Protection of Properties

1. Protect process water or potable water areas from coming in unintended contact with coatings, abrasives or waste materials. Cover openings to these areas to keep blasting abrasive and paint materials from entering the openings.

2. All permanent equipment and property shall be covered to protect it from abrasive and paint damage. Restrict and control wind borne fallout of residue and particulate matter from cleaning operations, and/or paint from the proximity of property or vehicles.

3. Schedule and coordinate Work to avoid damage from wind borne fallout. All damage to facilities, vehicles, property, etc. shall be cleaned, repaired or replaced.

C. Working Times

1. Unless otherwise approved, no Work is to be done between sunset and sunrise, local time. The times for work shall comply with Laws and Regulations.

2. Night Work: Submit to Engineer justification for the necessity of night work. If Engineer approves the need for night work, verify that the necessary dew point, humidity, surface and air temperature requirements are met. Provide proper lighting, safety or other required equipment. Engineer may revoke approval if night work is not in the best interest of Owner.

D. Access and Rigging

Inspect all rigging attachments prior to use and regularly during use. Assume responsibility for all existing and any added attachments.

E. Cleanliness

Work shall be performed in, or proximate to, a potable water processing facility and public water supply storage. Exercise extreme care to protect public water supplies. Maintain Work areas in clean and safe conditions at all times. Collect debris daily and place in covered containers. Store debris and waste in accordance with Laws and Regulations. Do not store in the vicinity of water processing or storage facilities. Dispose of debris and waste off site in accordance with Laws and Regulations.

F. Temperature and Humidity

Meet all temperature and humidity requirements of the paint manufacturer. No painting shall be performed when the relative humidity is greater than or expected to exceed 85%, or if the temperature of the substrate is, or is expected to become within 5 degrees Fahrenheit above the dew point during the application and the initial curing of the coatings.

1.06 COLOR AND PIPELINE MARKER SELECTIONS

A. General

1. Coatings

a. Owner will select colors to be used on the job. Prepare sample panels for finish and color, in advance, with the specified materials.

b. Match existing color coding of surfaces, mechanical and electrical equipment, etc. unless otherwise specified.

c. Process piping colors to meet Ten States Standards.

d. For those areas requiring safety color coding in accordance with OSHA regulations, the following colors shall be furnished:

(1) Fire Protection Equipment – Safety Red

(2) Danger – Safety Orange

(3) Caution – Safety Yellow

(4) Safety – Safety Green

2. Pipeline markers

a. Provide one-piece, custom-formed, snap-on, non-pressure sensitive, semi-rigid plastic markers for identifying the contents of each pipeline in conformance with ANSI A13. 1-1981. Pipe Line identification schedule and marker location requirements as specified hereinafter. Provide markers with legend printed in filled gothic letters and printed four times around marker to allow 360 degree visibility. Markers are to include flow direction arrows.

b. Materials: Provide markers with entire printed surface covered and sealed within outdoor grade acrylic plastic which is resistant to grease, acid, and other corrosive chemicals and conditions, and able to withstand temperatures from minus 40 to 180 degrees F. Furnish markers which are permanently self-tensioned to firmly grip pipe without the need for adhesives.

3. Small Pipe Markers: For outside pipe diameters 3/4-inch through 5 7/8-inch, provide markers that snap completely around the pipe.

4. Large Pipe Markers: For outside pipe diameters 6-inches and larger, provide strap-on type markers, which include stainless steel spring fasteners.

a. Letter Size and Color Field: Use gothic-style lettering with letter size and minimum color field width in accordance with the following:

| Pipe Outside Diameter Inches | Color Field Minimum Width Inches | Letter Size Inches |
|---|---|---|
| 3/4 to 1-1/4 | 8 | 1/2 |
| 1-1/2 to 2 | 8 | 3/4 |
| 2-1/2 to 6 | 12 | 1-1/4 |
| 8 to 10 | 24 | 2-1/2 |
| Over 10 | 32 | 3-1/2 |

## PART 2 -- PRODUCTS

### 2.01 MATERIALS

A. Paint Materials

1. Coating materials and thinners: manufactured by:

Carboline Company
350 Hanley Industrial Court
St. Louis, Missouri, 63144

ICI Paints
15885 West Sprague Road
Strongsville, OH 44136

MAB Paints
600 Reed Road
Broomall, PA 19008

Sherwin Williams Company
101 Prospect Street NW
Cleveland, OH 44115

Tnemec Company, Inc.
P. O. Box 1749
Kansas City, MO 64141

2. Substitutions: Allowed only at the time of bidding in accordance with Section 1100. Submittals of alternative systems for approval shall provide complete descriptions of the systems as to product numbers, number of coats, film thickness, etc.

B. Abrasives

Abrasives used for blast cleaning shall be those contained in the specifications of the Society for Protective Coatings (formerly Steel Structures Painting Council). Particular attention shall be given to the maximum particle size requirements. Proprietary abrasive materials (such as Black Beauty 1240 or Clemtex No. 2) may be used only upon written approval of the Engineer. Unless otherwise specified herein, the profile of the substrate shall achieve a 3 to 4 mil profile using 8/20 Mesh Silica Sand, G-25 Steel Grit, S-330 or 390 Steel Shot, 16 Mesh Garnet, 16 Grit Aluminum Oxide.

C. Tinting

Deliver paints and coatings to the job site ready-mixed. Job mixing and tinting allowed only with written approval of Engineer. Mixing shall only be done in mixing pails placed in suitably sized non-ferrous or oxide resistant metal pans.

## PART 3 -- EXECUTION

### 3.01 EQUIPMENT

A. All equipment, including but not limited to compressors, sand pots and paint pumps, shall be in good operating condition and of sufficient capacity to provide satisfactory results for cleaning and painting.

B. Spray equipment and tip size shall be used as recommended in the paint or coatings manufacturer's instructions.

C. Compressed air for blasting and painting shall be free from detrimental amounts of water and oil. Adequate traps and/or dryers shall be provided.

D. Contractor must have sufficient explosion proof ventilation equipment to properly and efficiently expel all dust and paint fumes around the work area to the atmosphere. All equipment to be used in a confined space shall be explosion proof.

E. Contractor shall have available at the site, all inspection and measuring equipment and devices such as dry and wet film thickness gauges, wet bulk dry measuring equipment, substrate temperature measuring equipment, holiday detector equipment, etc. as required to determine compliance with specifications and manufacturer requirements or recommendations..

3.02 SURFACE PREPARATION

A. General

1. Clean substrates prior to any application of paint or coating. Surfaces shall be free of oils, grease, dirt, debris or any other contaminant that may affect the integrity of the specified coating.

2. Surface and ambient temperatures to be minimum 5 degrees Fahrenheit higher than the dew point temperature prior to, and during, surface preparation.

3. Inspect shop painted surfaces and touch-up all scratched, chipped or abraded areas. De-scale by wire brush, or other method, any coating of scale. Produce a suitable surface for re-coating.

B. Metal Substrates

1. Grind to remove sharp edges, weld protrusions and other protrusions. Grind sharp edges to a 1/8-inch radius minimum. Completely remove weld spatter.

2. Surfaces to be free from oil, grease, mud, dust, moisture, old paint, or other foreign matter.

3. Prime surfaces cleaned to bare metal before any rusting takes place. Cleaned surfaces shall not be allowed to stand overnight without a primer coat applied. Apply primer during the same daylight period that the cleaning was accomplished.

4. Feather and smooth existing coatings at edges where spot cleaning is specified. Achieve proper blending of new paint to old paint. Peeling of old paint is not acceptable.

5. Blow down with dry compressed air, sweep or vacuum surfaces following blast cleaning operations.

6. Clean surfaces in accordance with the Surface Preparation Specifications, latest edition, of the Society for Protective Coatings (formerly Steel Structures Painting Council) to the following degrees as specified in appendices to this specification section:

SSPC-SP1, Solvent Cleaning.
SSPC-SP2, Hand Tool Cleaning.
SSPC-SP3, Power Tool Cleaning.
SSPC-SP5, White Metal Blast Cleaning.
SSPC-SP6, Commercial Blast Cleaning.
SSPC-SP7, Brush-off Blast Cleaning.
SSPC-SPl0, Near-White Blast Cleaning.
SSPC-SP11, Power Tool Cleaning to Bare Metal.

7. Surface preparation shall create a profile as recommended by coating manufacturer.

C. Concrete and Masonry Substrates

1. Cure concrete and masonry a minimum of 30 days before surface preparation, and painting begins.

2. Test concrete and masonry for moisture content using test method recommended by the paint manufacturer. Do not begin surface preparation, or painting until moisture content is acceptable to manufacturer.

3. Prepare concrete surfaces to receive coatings in accordance with SSPC-13 – Concrete Surface Preparation. Remove contaminants, open bugholes, surface voids, air pockets, and other subsurface irregularities. Do not expose underlying aggregate. Use dry, oil-free air for blasting operations. Surface texture after blasting shall be similar to that of medium grit sandpaper. Remove residual abrasives, dust, and loose particles by vacuuming or blowing with high pressure air.

D. Wood and Drywall Substrates

1. Prepare wood and drywall substrates by removing all dirt, oil and other foreign substances with mineral spirits, scrapers, and sandpapers as required. Finished surfaces exposed to view shall be made smooth by sandpapering and shall be free of dust.

E. Previously-Painted Surfaces

1. Totally remove existing paint when surface is to be submerged, in a severe environment, paint is less than 85% intact, brittle, eroded or has underfilm rusting.

2. Surfaces which are greater than 85% intact require removal of failed coatings and then spot priming. Spot priming is in addition to coats specified.

3. Remove surface contamination such as oil, grease, loose paint, mill scale, dirt, foreign matter, rust, mold, mildew, mortar, efflorescence, and sealers.

4. Clean and dull glossy surfaces prior to painting in accordance with the manufacturer’s recommendations.

5. Check existing coatings for compatibility with new paint system. If incompatible, totally remove existing paint system or apply a barrier coating recommended by the paint manufacturer. Remove existing paints

6. Where existing coatings are to be over-coated, prepare a test patch of approximately 3 square feet over existing surface. Allow test patch to cure thoroughly and test for adhesion. If proper adhesion is not achieved remove existing paint and repaint.

3.03 COATING SCHEDULE

A. The coating systems to be used for each surface are listed in Appendix #1 to this Specification Section.

B. The types, products, number of coats, minimum dry film thickness per coat and all other relevant information for each coating system to be applied under this Contract are listed in Appendix #2 to this Specification Section.

C. The surfaces shall be coated under this Contract for all new construction that is part of this Contract and at all locations where existing coatings were damaged during construction.

3.04 COATING SYSTEM APPLICATION

A. General

1. Apply to a dry film thickness as specified by the manufacturer, unless otherwise specified herein. Allow proper curing times between re-coatings. Vary color slightly between successive coats.

2. Finish coats shall be smooth, uniform in color, free of brush marks, runs, laps, dry spray, overspray, holidays, missed or skipped areas. Cut sharp edge of paint, without overlapping, where work joins other materials or where a color change occurs.

3. Mix all paints and coatings in strict accordance with applicable portions of these Specifications and the paint manufacturer's recommendations.

4. Provide air-moving equipment as necessary to adequately ventilate Work areas. Exercise care when working within structures such that volatile gases do not accumulate possibly resulting in an explosion or fire hazard, or affecting the curing time of the paint.

6. Surfaces that have been shop primed in accordance with these specifications do not require field prime coats unless recommended by the coating manufacturer. Clean and prime all unprimed and abraded surfaces.

7. After proper cleaning and surface preparation, brush apply primer to all connection points, including weld seams, edges, rivets and other joints.

8. Roller covers shall be synthetic nap with nap thickness per the paint manufacturer's recommendations.

9. Remove all spilled, splashed or splattered paint from all surfaces. Touch up all damaged finishes. Leave Work areas in clean, pre-construction, conditions.

10. Shop Preparation and Primers

a. Shop Preparations - As specified, prepare metal surfaces in accordance with Society for Protective Coatings (formerly Steel Structures Painting Council) SSPC-SP10 "Near White Blast Cleaning". Remove all cleaning residue and dust before applying primer.

b. Shop Primers - Use specified primers for coatings system specified. Spray prime all metals to be field welded within two inches of the plate edges to a dry film thickness of 3.0 mils.

c. Field Surface Preparations - Clean field welded, unprimed, damaged or abraded metal surfaces in accordance with the Society for Protective Coatings (formerly Steel Structures Painting Council) SSPC-SP10 "Near White Blast Cleaning". Apply block filler to fill voids and irregularities for masonry and concrete surfaces. Sand wood substrates to fresh wood. Solvent clean galvanized substrates per Society for Protective Coatings (formerly Steel Structures Painting Council) SSPC-SP1, "Solvent Cleaning".

d. Field Spot Primers - Use only primers specified within each coatings system.

## 3.05 INSPECTION

A. General

1. Inspect all cleaning, surface preparation and painting. Provide access for inspection by paint manufacturer and Engineer.

2. Notify Engineer at least two weeks in advance of all cleaning and priming including that to be performed in a shop.

3. Provide at the site SSPC VIS-1 Pictorial Standards and a dry film thickness gage for use by the Engineer. Dry film thickness gages shall conform to ASTM D-1186 and shall be of magnetic pull off or magnetic flux for coatings over ferrous metal substrates. Eddy current type gages shall be used on non ferrous substrates. In no case shall destructive dry film thickness gages be allowed. Provide a low voltage holiday detector to check the finished paint film integrity.

4. Expeditiously correct all defective work.

- END OF SECTION -

## SECTION 09900

## Appendix 1

| Surface | Coating System Number (See Attached Appendix for System Descriptions) | |
|---|---|---|
| | New Construction | Maintenance (See Note 1) |
| **Steel (Structural, Tanks, Equipment, Panels, Etc.):** | | |
| Steel - Interior or Exterior (submerged) - NSF Std. 61 Certified | 1 | 1 |
| Steel - Interior (non-submerged) | 2 | 2, 2A, 2C |
| Steel - Exterior (non-submerged) | 3 | 3, 3A, 3B |
| Steel - Exterior (below grade) | 1 | 1 |
| **Ductile and Cast Iron (Piping, Pumps and Valves):** | | |
| Ductile or Cast Iron - Interior or Exterior (submerged) - NSF Std. 61 Certified | 1 | 1 |
| Ductile or Cast Iron - Interior (exposed) | 2 | 2, 2A, 2C |
| Ductile or Cast Iron - Exterior (exposed) | 3 | 3, 3A, 3B |
| Ductile or Cast Iron - Interior/Exterior (below grade) | See Piping Specifications | See Piping Specifications |
| Ductile or Cast Iron - Interior (in galleries or valve pits) | 2, 4 | 4 |
| **Other Metals (Galvanized Steel, Black Iron, Copper, Bronze, Aluminum):** | | |
| Interior (See Note 2 for Copper, Bronze and Aluminum) | 2B | 2B |
| Exterior (See Note 2 for Copper, Bronze and Aluminum) | 3B | 3B |
| **Concrete:** | | |
| Concrete - Interior or Exterior (submerged) - NSF Std 61 Certified | 5 | 5 |
| Concrete - Interior (non-submerged) (See Note 2) | 6 | 6 |
| Concrete - Exterior (non-submerged) (See Note 2) | 7 | 7 |
| Concrete - Exterior (below grade) | 8 | 8 |
| Concrete - Floors | 9 | 9 |
| Concrete - Secondary Containment | 10 | 10 |
| **Masonry:** | | |
| Masonry - Interior | 6 | 6 |
| Masonry - Exterior (above grade) (See Note 2) | 7 | 7 |
| Masonry - Exterior (below grade) | 6 | 6 |
| **Drywall:** | | |
| Drywall - Interior | 11 | 11 |
| **Wood:** | | |
| Wood - Interior | 12 | 12 |
| Wood - Exterior | 13 | 13 |
| **Other Surfaces:** | | |
| PVC and FRP - Interior (See Note 2) | 14 | 14 |
| PVC and FRP - Exterior (See Note 2) | 15 | 15 |

**Notes:**

1. Refer to Specification Section 9900, Paragraph 3.02 to determine if overecoating or complete blasting is applicable.
2. These surfaces are to be coated only when specifically required by the Contract Documents.

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 1**
**INTERIOR/EXTERIOR STEEL, SUBMERGED**
**Generic Description: Three-Coat Epoxy (NSF Std. 61 Certified)**
**Surface Preparation: SSPC-SP10**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 891 HS | 4-6 | Carboguard 891 HS | 4-6 | Carboguard 891 HS | 4-6 | 12 |
| ICI IPC Devoe Dulux | IPC Interseal 670HS | 4-6 | IPC Interseal 670HS | 4-6 | IPC Interseal 670HS | 4-6 | 12 |
| Sherwin-Williams Company | Macropoxy 646 PW | 3 | Macropoxy 646 PW | 4 | Macropoxy 646 PW | 5 | 12 |
| Tnemec Company | Series L140 Pota-Pox Plus | 4-6 | Series L140 Pota-Pox Plus | 4-6 | Series L140 F Pota-Pox Plus | 4-6 | 12 |

**Treatment Plant Coating System No. 2**
**INTERIOR STEEL, NON-SUBMERGED**
**Generic Description: Three-Coat Epoxy**
**Surface Preparation: SSPC-SP10**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 893 | 3-5 | Carboguard 890 VOC | 4-6 | Carboguard 890 VOC | 4-6 | 11 |
| ICI IPC Devoe Dulux | IPC Interseal 670HS | 4-6 | IPC Interseal 670HS | 4-6 | IPC Interthane 870UHS | 4-6 | 12 |
| Sherwin-Williams Company | Macropoxy 646 PW | 3 | Macropoxy 646 | 4 | Macropoxy 646 | 5 | 11 |
| Tnemec Company | Series L140 Pota-Pox Plus | 3-5 | Series L69 Hi-Build Epoxoline II | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | 11 |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 2A**
**EXTERIOR**
**Generic Description: Three-Coat Epoxy**
**Surface Preparation: SSPC-SP-6 at spot primed locations, per manufacturer requirements at other locations**

| Manufacturer | Spot Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 893 | 3-5 | Carboguard 890 VOC | 4-6 | Carboguard 890 VOC | 4-6 | 11 |
| MAB Paints | Ponamid 54 Series | 3-5 | Plymastic 044 | 4-6 | Plymastic 044 | 4-6 | 11 |
| Sherwin-Williams Company | Tile Clad II Hi-Bild Primer | 3-5 | Macropoxy 646 | 4-6 | Macropoxy 646 | 4-6 | 11 |
| Tnemec Company | Series L140 Pota-Pox Plus | 3-5 | Series L69 Hi-Build Epoxoline II | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | 11 |

**Treatment Plant Coating System No. 2B**
**INTERIOR GALVANIZED, IRON, COPPER BRONZE**
**Generic Description: Penetrating Sealer/Epoxy**
**Surface Preparation: Per manufacturer requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Rustbond Penetrating Sealer | 1-2 | Carboguard 890 VOC | 4-6 | Carboguard 890 VOC | 4-6 | 9 |
| MAB Paints | MAB Ply-Tile Rust Seal | 1-2 | Plymastic 044 | 4-6 | Plymastic 044 | 4-6 | 9 |
| Sherwin-Williams Company | Macropoxy 920 Pre-Prime | 1-2 | Macropoxy 646 | 4-6 | Macropoxy 646 | 4-6 | 9 |
| Tnemec Company | Series 27 Typoxy | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | 12 |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 3**
**EXTERIOR**
**Generic Description: Epoxy/Epoxy/Polyurethane**
**Surface Preparation: SSPC-SP10**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 893 | 3-5 | Carboguard 890 VOC | 3-5 | Carbothane 134 HG | 2-3 | 8 |
| MAB Paints | Ponamid 54 Series | 3-5 | Ply-Tile 520 HB | 3-5 | Ply-Thane 890 HS | 2-3 | 8 |
| Sherwin-Williams Company | Macropoxy 646 | 3-5 | Macropoxy 646 | 3-5 | Hi-Solids Polyurethane | 2-3 | 8 |
| Tnemec Company | Series L140 Pota-Pox Plus | 3-5 | Series L69 Hi-Build Epoxoline II | 3-5 | Series 1075 Endura-Shield | 2-3 | 8 |

**Treatment Plant Coating System No. 3A**
**EXTERIOR**
**Generic Description: Epoxy/Epoxy/Polyurethane**
**Surface Preparation: SSPC-SP-6 at spot primed locations, per manufacturer requirements at other locations**

| Manufacturer | Spot Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 893 | 3-5 | Carboguard 890 VOC | 3-5 | Carbothane 134 HG | 2-3 | 8 |
| MAB Paints | Ponamid 54 Series | 3-5 | Ply-Tile 520 HB | 3-5 | Ply-Thane 890 HS | 2-3 | 8 |
| Sherwin-Williams Company | Recoatable Epoxy Primer | 3-5 | Recoatable Epoxy Primer | 3-5 | Hi-Solids Polyurethane | 2-3 | 8 |
| Tnemec Company | Series L140 Pota-Pox Plus | 3-5 | Series L69 Hi-Build Epoxoline II | 3-5 | Series 1075 Endura-Shield | 2-3 | 8 |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 3B**
**EXTERIOR**
**Generic Description: Penetrating Sealer/Epoxy/Polyurethane**
**Surface Preparation: Per manufacturer requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Rustbond Penetrating Sealer | 1-2 | Carboguard 890 VOC | 4-6 | Carbothane 134 HG | 2-3 | 8 |
| MAB Paints | MAB Ply-Tile Rust Seal | 1-2 | Ply-Tile 520 HB | 3-5 | Ply-Thane 890 HS | 2-3 | 8 |
| Sherwin-Williams Company | Macropoxy 920 Pre-Prime | 1-2 | Recoatable Epoxy Primer | 3-5 | Hi-Solids Polyurethane | 2-3 | 8 |
| Tnemec Company | Series 27 Typoxy | 4-6 | Series L69 Hi-Build Epoxoline II | 3-5 | Series 1075 Endura-Shield | 2-3 | 9 |

**Treatment Plant Coating System No. 4**
**INTERIOR**
**Generic Description: Petrolatum Wax/Wax Tape**
**Surface Preparation: SSPC-SP2**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| | Denso Paste Coat | per Mfr. | Denso LT/Densyl Tape Wrap | per Mfr. | Densoclad 40 Wrap | per Mfr. | 50 (nominal) |
| | Petro Primer Paste | per Mfr. | Petro Mastic/Petro Tape | per Mfr. | Petro 250 Overwrap Tape | per Mfr. | 60 (nominal) |
| Trenton Corporation | Wax-Tape Primer | per Mfr. | #2A Wax-Tape | per Mfr. | N/A | | 80 (nominal) |

**Treatment Plant Coating System No. 5**
**INTERIOR/EXTERIOR (SUBMERGED)**
**Generic Description: Cementitious Crystalline Waterproofing - NSF Std. 61 Certified**
**Surface Preparation: Brush Off Blast**

| Manufacturer | Prime Coat | lb/SY | Second Coat | lb/SY | Third Coat | DFT (mils) | Minimum Total (lb/SY) |
|---|---|---|---|---|---|---|---|
| Vandex International Ltd. | Vandex Super | 1.5 | Vandex Super | 1.5 | N/A | | 3 |
| Xypex Chemical Corporation | Xypex Concentrate | 1.5 | Xypex Modified | 1.5 | N/A | | 3 |

**Treatment Plant Coating System No. 6**
**INTERIOR**
**Generic Description: Block Filler/Epoxy**
**Surface Preparation: Brush Off Blast (for concrete), Clean and Dry (for masonry)**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 501 | Per Mfr. | Carboguard 890 VOC | 4-6 | Carboguard 890 VOC | 4-6 | 8 (+filler) |
| ICI IPC Devoe Dulux | Devoe Tru-Glaze-WB 4015 | Per Mfr. | Devoe Tru-Glaze-WB 4426 | 2-4 | Devoe Tru-Glaze-WB 4426 | 2-4 | 4 (+filler) |
| Sherwin-Williams Company | Cement-Plex 875 | Per Mfr. | Macropoxy 646 | 4-6 | Macropoxy 646 | 4-6 | 8 (+filler) |
| Tnemec Company | Series 130 Envirofill | Per Mfr. | Series L69 Hi-Build Epoxoline II | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | 8 (+filler) |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 7**
**EXTERIOR**
**Generic Description: Block Filler/Acrylic**
**Surface Preparation: Brush Off Blast (for concrete), Clean and Dry (for masonry)**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carbocrylic 650 Acrylic Block Filler | Per Mfr | Carbocrylic 3359 | 2-3 | Carbocrylic 3359 | 2-3 | 4 (+ filler) |
| MAB Paints | Block Kote #2000 | Per Mfr | Rust-O-Lastic Gloss | 2-3 | Rust-O-Lastic Gloss | 2-3 | 4 (+ filler) |
| Sherwin-Williams Company | Heavy Duty Block Filler | Per Mfr | DTM Acrylic Gloss Coating | 2-3 | DTM Acrylic Gloss Coating | 2-3 | 4 (+ filler) |
| Tnemec Company | Series 180 W.B. Tneme-Crete | Per Mfr | Series 28 Tufcryl | 2-3 | Series 28 Tufcryl | 2-3 | 4 (+ filler) |

**Treatment Plant Coating System No. 8**
**EXTERIOR**
**Generic Description: Coal Tar Epoxy**
**Surface Preparation: SSPC-SP10 (for metals) or SSPC-SP6 (for concrete/masonry)**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Bitumastic 300 M | 16-20 | N/A | | N/A | | 16 |
| MAB Paints | Ply-Tile Epoxy Tar Coating | 8-10 | Ply-Tile Epoxy Tar Coating | 8-10 | N/A | | 16 |
| Sherwin-Williams Company | Hi-Mil Sher-Tar Epoxy | 16-20 | N/A | | N/A | | 16 |
| Tnemec Company | Series 46H-413 Hi-Build Tneme-Tar | 16-20 | N/A | | N/A | | 16 |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 9**
**INTERIOR, CONCRETE FLOORS**
**Generic Description: Epoxy**
**Surface Preparation (including surfacers/fillers): Per Manufacturer Requirement**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat (furnish with manufacturer-approved skid retardant additive) | DFT (mils) | Third Coat - Optional (furnish with manufacturer-approved skid retardant additive) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carboguard 890 VOC | 6-8 | Carboguard 890 VOC | 6-8 | Carboguard 890 VOC | 6-8 | 18 |
| MAB Paints | Crete Prime 51-P-3 | 2-3 | Ply-Mastic 044 | 5-7 | Ply-Mastic 044 | 5-7 | 12 |
| Sherwin-Williams Company | ArmorSeal WB Epoxy Primer/Sealer | 5-7 | ArmorSeal 700 HS Water Based Epoxy | 6.5-7.5 | ArmorSeal 700 HS Water Based Epoxy | 6.5-7.5 | 18 |
| Tnemec Company | Series 201 Epoxoprime | 6-8 | Series 281 Tneme-Glaze | 6-8 | Series 281 Tneme-Glaze | 6-8 | 18 |

**Treatment Plant Coating System No. 10**
**INTERIOR, SECONDARY CONTAINMENT**
**Generic Description: Epoxy Novalac**
**Surface Preparation (including surfacers/fillers): Per Manufacturer Requirement**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Phenoline 379 | 10-15 | Phenoline 379 | 10-15 | N/A | | 25 |
| Sherwin-Williams Company | Tank Clad HS | 5-8 | Tank Clad HS | 5-8 | | | 10 |
| Tnemec Company | Series 201 Epoxoprime | 6-8 | Series 273 Stranlok | 20-25 | Series 282 Tneme-Glaze | 6-8 | 32 |

**Treatment Plant Coating System No. 11**
**INTERIOR, DRYWALL**
**Generic Description: Acrylic/Acrylic**
**Surface Preparation: Surface shall be clean and dry**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| ICI IPC Devoe<br><br>Dulux | Dulux Lifemaster Interior Acrylic Eggshell | 1-2 | Dulux Lifemaster Interior Acrylic Eggshell | 1-2 | | | 3 |
| Sherwin-Williams<br><br>Company | Harmony Interior latex Primer | 1-2 | Harmony Interior latex Eg-Shel | 1-2 | Harmony Interior latex Eg-Shel | 1-2 | 3 |

**Treatment Plant Coating System No. 12**
**WOOD, INTERIOR**
**Generic Description: (Acrylic) Primer/Acrylic/Acrylic**
**Surface Preparation: Surface shall be clean & dry and/or as per manufacturer's requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| ICI IPC Devoe<br><br>Dulux | Dulux Prep & Prime 1020 Wall & Woodwork | 1-2 | Dulux Lifemaster Interior Semi-Gloss Enamel | 2-3 | Dulux Lifemaster Interior Semi-Gloss Enamel | 2-3 | 5 |
| Sherwin-Williams<br><br>Company | Harmony Interior Latex Primer | 1-2 | Harmony Interior Latex Semi-Gloss | 1-2 | Harmony Interior Latex Semi-Gloss | 1-2 | 3 |

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## Appendix 2

**Treatment Plant Coating System No. 13**
**EXTERIOR METAL- DISTRIBUTION GARAGE**
**Generic Description: (Acrylic) Primer/Acrylic/Acrylic**
**Surface Preparation: Surface shall be clean & dry and/or as per manufacturer's requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carbocrylic 120 | 1-2 | Carbocrylic 3359 | 2-3 | Carbocrylic 3359 | 2-3 | 6 |
| MAB Paints | Ply-Tile 520-W-45-Epoxy | 2-3 | Rust-O-Lastic Gloss | 2-3 | Rust-O-Lastic Gloss | 2-3 | 6 |
| Sherwin-Williams Company | A-100 Exterior Wood Primer | 1-2 | DTM Acrylic Gloss Coating | 2-3 | DTM Acrylic Gloss Coating | 2-3 | 6 |
| Tnemec Company | Series 36 Undercoater | 2-3 | Series 28 Tufcryl | 2-3 | Series 28 Tufcryl | 2-3 | 6 |

**Treatment Plant Coating System No. 14**
**INTERIOR- PVC & FRP**
**Generic Description: (Acrylic) Primer/Epoxy/Epoxy**
**Surface Preparation: Surface shall be clean & dry and/or as per manufacturer's requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat (Optional) | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Carbocrylic 120 | 1-2 | Carboguard 890 VOC | 4-6 | Carboguard 890 VOC | 4-6 | 10 |
| ICI IPC Devoe Dulux | IPC Interseal 670HS | 5-8 | IPC Interthane 870UHS | 3-4 | | | 8 |
| Sherwin-Williams Company | DTM Bonding Primer | 2-3 | Macropoxy 646 | 4-6 | Macropoxy 646 | 4-6 | 10 |
| Tnemec Company | Series L140 Pota-Pox Plus | 2-3 | Series L69 Hi-Build Epoxoline II | 4-6 | Series L69 Hi-Build Epoxoline II | 4-6 | 10 |

## Section 09900

## Appendix 2

**Treatment Plant Coating System No. 15**
**INTERIOR METAL- DISTRIBUTION GARAGE**
**Generic Description: (Acrylic) Primer/Acrylic/Acrylic**
**Surface Preparation: Surface shall be clean & dry and/or as per manufacturer's requirements**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | Rustbond Penetrating Sealer | 1-2 | Carbocrylic 3359 | 2-3 | Carbocrylic 3359 | 2-3 | 6 |
| MAB Paints | Ply-Tile 520-W-45-Epoxy | 2-3 | Rust-O-Lastic Gloss | 2-3 | Rust-O-Lastic Gloss | 2-3 | 6 |
| Sherwin-Williams Company | DTM Bonding Primer | 2-3 | DTM Acrylic Gloss Coating | 2-3 | DTM Acrylic Gloss Coating | 2-3 | 6 |
| Tnemec Company | Series 20 Pota-Pox | 2-3 | Series 28 Tufcryl | 2-3 | Series 28 Tufcryl | 2-3 | 6 |

**Treatment Plant Coating System No. 16**
**INTERIOR STEEL WATER TANKS (NSF STD 61 CERTIFIED)**
**Generic Description: Epoxy/Epoxy or Modified Polyurethane**
**Surface Preparation: SSPC-SP10**

| Manufacturer | Prime Coat | DFT (mils) | Second Coat | DFT (mils) | Third Coat | DFT (mils) | Minimum Total DFT (mils) |
|---|---|---|---|---|---|---|---|
| Carboline Company | | | Polibrid 705 (light tan or beige) | 30-35 | | | 30 |
| Raven Lining System | Aquatapoxy A6 or A7 | 16-20 | Aquatapoxy A6 or A7 | 16-20 | | | 32 |
| Tnemec Company | FC-22 Epoxoline | 16-20 | FC-22 Epoxoline | 16-20 | | | 32 |

SECTION 10400

IDENTIFYING DEVICES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on the Drawings and specified herein.

B. Principal items of work include:

1. Plastic engraved door and informational signs as indicated on the Drawings.

2. Safety signs

### 1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:

1. Color and finish samples for all nameplates, signs and building name letters.

2. Shop Drawings shall include, but not be limited to:

a. Complete details for all signs and building name letters giving sizes and styles of lettering and colors.

b. Complete schedules for all nameplates, signs, and building name letters giving location, message, letter, size, color, and method of attachment.

c. Details of fabrication and attachment of all items.

### 1.03 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials in unopened, unbroken and undamaged original packaging bearing the manufacturer's label and identification for installation.

B. Handle all materials with care to prevent defacement of any nature.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications, provide products from one of the following manufacturers:

1. Andco Industries Corporation

2. Innerface Architectural Signage Incorporated

3. Environmental Sign Systems

2.02 MATERIALS

A. Signs

1. Interior signs shall be self extinguishing plastic with raised letters meeting the requirements of the American with Disabilities Act of 1990; total thickness minimum of 0.125 inch; rounded corners.

2. Exterior signs shall be aluminum with vinyl lettering and numbering.

B. Character size and style shall be 3/4 inch high minimum upper case Helvetica. Spacing and proportions of letters shall be in strict accordance with the Americans with Disabilities Act of 1990.

C. Colors shall be as selected by the Owner from the manufacturer standard colors.

D. Materials shall be suitable for exterior or interior exposure as applicable.

2.03 ACCESSORIES

A. Mounting Hardware: Stainless steel screws.

B. Tape Adhesive: Double sided tape, permanent adhesive.

2.04 FABRICATION

A. All items specified herein to be factory fabricated to the extent practicable.

B. Provide all attachments and anchors necessary for concealed installments for door numbers, room name plates, and bulletin boards.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All materials specified herein shall be installed in compliance with the approved manufacturer's printed specifications. Mounting devices, bolts, screws, nuts and the like shall be of high strength aluminum or stainless steel. The final location of each sign shall be as determined by the Engineer.

B. Plastic door numbers and room name plates shall be attached stainless steel oval Phillips head screw at each corner.

1. Submit a schedule of door numbers and name plates to the Engineer for approval.

2. Install door and name plates after final field finish has been applied and thoroughly dried.

3.02 ADJUSTMENT AND CLEANING

A. After completion of project, remove all protective devices, touch up as necessary and clean all exposed surfaces with a mild solution of detergent and warm water. Leave all surfaces in a neat and clean condition.

3.03 SCHEDULES

A. FIRE RELATED SIGNS provide each sign with wording and pictogram. Signs shall have red background and white letters and pictogram.

| **Wording** | **Size** | **Quantity** |
|---|---|---|
| FIRE EXTINGUISHER | 7x7 | 10 |
| FIRE EXIT (stair) | 7x7 | 1 |

B. INFORMATIONAL SIGNAGE.

| **Wording** | **Size** | **Quantity** |
|---|---|---|
| TOILET (with international and accessible pictogram) for Men or Women as required | 7x7 | 4 |

C. CAUTION SIGNS shall have a yellow background with the word CAUTION 2 inches high with white letters and black background centered above wording below in black letters. Each sign shall be provided with pictogram showing figure in compliance with sign (i.e. a figure wearing glasses)

| **Wording** | **Size** | **Quantity** |
|---|---|---|
| EAR PROTECTION MUST BE WORN IN THIS AREA | 7x17 | 4 |
| EYE PROTECTION MUST BE WORN IN THIS AREA | 7x17 | 4 |
| HARD HATS MUST BE WORN IN THIS AREA | 7x17 | 7 |
| NON-POTABLE WATER – DO NOT DRINK | 7X17 | 2 |

D. SAFETY SIGNS. Signs shall comply with ANSI Z S35 requirements.

| **Wording** | **Size** | **Quantity** |
|---|---|---|
| EMERGENCY SHOWER (with pictogram) | 7x7 | 8 |
| EMERGENCY EYEWASH (with pictogram) | 7x7 | 8 |
| KEEP DOOR CLOSED FOR FIRE SAFETY | Note 1 | 4 |
| NO ENTRY<br>AUTHORIZED PERSONNEL ONLY<br>(with pictogram) | 6x3 | 10 |

Note 1: Sign shall be 2½ inches high x length required. Sign shall be centered.

E. EXTERIOR HAZARDOUS MATERIAL BUILDING SIGNAGE

1. The authority having jurisdiction shall be consulted regarding the quantity and placement of identification NFPA 704 placard to assist in response to incidents at locations.

| **Wording** | **Size** | **Quantity** |
|---|---|---|
| In accordance with NFPA 704 | 10X10 | 2 |

- END OF SECTION -

SECTION 10522

FIRE EXTINGUISHERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Furnish and install fire extinguishers as shown on the Drawings and specified herein.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of these Specifications the Work shall conform to the applicable requirements of the following documents:

1. NFPA 10 - Portable Fire Extinguishers

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:

1. Complete detail and installation drawings for Fire Extinguisher Cabinets.

2. Manufacturer's data sheets and verification of U.L. ratings.

PART 2 -- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Specifications provide products from one of the following manufacturers:

1. Kidde Fire Extinguisher Company

2. Ansul Fire Protection

3. Potter - Roemer

4. J. L. Industries

2.02 MATERIALS

A. Dry Chemical (DC) Fire Extinguishers

1. Provide where indicated on drawings, 10 lb. capacity, hand portable, with heavy duty steel wall mount, tri-class dry chemical type, with Underwriters' Laboratories rating of 4-A: 60 BC.

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B. Carbon Dioxide ($CO_2$) Fire Extinguishers

1. Provide 10 lb. capacity, portable carbon dioxide type with heavy duty steel wall mounts, having Underwriters' Laboratories rating of 10-BC. Provide one at each door from electrical room.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Fire extinguishers shall be installed where directed by the Engineer.

B. Wall mounts for extinguishers shall be securely mounted to masonry with lag bolts and shields.

C. Fire extinguishers shall be installed so that the top of the fire extinguisher is not more than 5 feet above the floor.

- END OF SECTION -

# SECTION 10523

# FIRST AID CABINETS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Furnish and install first aid cabinets as shown on the Drawings and as specified herein. Coordinate work in this Section with painting and marking as specified in Section 09900, Painting. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

### 1.02 SUBMITTALS

A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

### 1.03 MANUFACTURERS

A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

## PART 2 -- PRODUCTS

### 2.01 FIRST AID CABINET

A. The first aid cabinets shall be a Fisher Scientific Co. Catalog #19-035-116, or equal. Provide one first aid cabinet. Mounting brackets for masonry mounting shall be provided. Cabinet shall be field located as directed by the Engineer.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. First aid cabinet shall be installed where directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.

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- END OF SECTION -

# SECTION 11000

# EQUIPMENT GENERAL PROVISIONS

## PART 1 -- GENERAL

### 1.01 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. All equipment, materials, and installations shall conform to the requirements of the most recent editions with latest revisions, supplements, and amendments of the specifications, codes, and standards listed in Section 01090, Reference Standards.

### 1.02 PERFORMANCE AFFIDAVITS

A. When required in the individual equipment Specifications, the Contractor shall submit manufacturer's Performance Affidavits for equipment to be furnished.

B. By these affidavits, each manufacturer must certify to the Engineer and the Owner, jointly, that he has examined the Contract Documents and that the equipment, apparatus, or process he offers to furnish will meet in every way the performance requirements set forth or implied in the Contract Documents.

C. The Contractor must transmit to the Engineer three (3) original copies of the affidavit given him by the manufacturer or supplier along with the initial Shop Drawing submittals.

D. The Performance Affidavit must be signed by an officer of the basic corporation, partnership, or company manufacturing the equipment and witnessed by a notary public.

E. The Performance Affidavit shall have the following format:

| | |
|---|---|
| Address to: | Kentucky American Water c/o Hazen and Sawyer |
| Reference: | Richmond Rd. Station WTP Improvements |
| Text: | (Manufacturer's Name) has examined the Contract Documents and hereby state that the (Product) meets in every way the performance requirements set forth or implied in Section ____ of the Contract Documents. |
| Signature: | Corporate Officers shall be Vice President, or higher. (Unless statement authorizing signature is attached.) |

### 1.03 SHOP DRAWINGS

A. Shop Drawings shall be submitted to the Engineer for all equipment in accordance with Section 01300, Submittals and shall include the following information in addition to the requirements of Section 01300, Submittals:

1. Performance characteristics and descriptive data.
2. Detailed equipment dimensional drawings and setting plans.

3. General lifting, erection, installation, and adjustment instructions, and recommendations.

4. Complete information regarding location, type, size, and length of all field welds in accordance with "Standard Welding Symbols" AWS A2.0 of the American Welding Society. Special conditions shall be fully explained by notes and details.

5. The total uncrated weight of the equipment plus the approximate weight of shipped materials. Support locations and loads that will be transmitted to bases and foundations. Exact size, placement, and embedment requirements of all anchor bolts.

6. Details on materials of construction of all components including applicable ASTM designations.

7. Information on bearing types and bearing life.

8. Gear box design and performance criteria and AGMA service factor.

9. Piping schematics.

10. Motor data sheet indicating motor horsepower; enclosure type; voltage; insulation class; temperature rise and results of dielectric tests; service-rating; rotative speed; motor speed-torque relationship; efficiency and power factor at ½, ¾, and full load; slip at full load; running, full load, and locked rotor current values; and safe running time-current curves.

11. Equipment and motor protective device details. Connection diagrams for motor and all protective devices.

12. Equipment shop coating systems, interior and exterior.

13. Panel layout drawings, schematic wiring diagrams, and component product data sheets for control panels.

14. A list of spare parts and special tools to be provided.

15. Any additional information required to show conformance with the equipment specifications.

16. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues.

B. SHOP DRAWINGS ON ITEMS REQUIRING PERFORMANCE AFFIDAVITS WILL NOT BE REVIEWED UNTIL ACCEPTABLE PERFORMANCE AFFIDAVITS ARE RECEIVED.

1.04 OPERATION AND MAINTENANCE INSTRUCTION/MANUALS

A. Operation and Maintenance (O&M) manuals shall be submitted in accordance with Section 01300, Submittals.

B. O&M manuals shall include instructions, equipment ratings, technical bulletins, and any other printed matter such as wiring diagrams and schematics, prints or drawings, containing full information required for the proper operation, maintenance, and repair of the equipment. Included in this submission shall be a spare parts diagram, complete spare parts list, bill of materials, OEM part numbers and manufacturer's catalog information of all equipment components.

C. Each set of instructions shall be bound together in appropriate three-ring binders with a detailed Table of Contents.

D. Written operation and maintenance instructions shall be required for all equipment items supplied for this project. The amount of detail shall be commensurate with the complexity of the equipment item.

E. Information not applicable to the specific piece of equipment installed on this project shall be struck from the submission.

F. Information provided shall include a source of replacement parts and names of service representatives, including address and telephone number.

G. Extensive pictorial cuts of equipment are required for operator reference in servicing.

H. When written instructions include Shop Drawings and other information previously reviewed by the Engineer, only those editions thereof which were approved by the Engineer, and which accurately depict the equipment installed, shall be incorporated in the instructions.

1.05 GENERAL INFORMATION AND DESCRIPTION

A. All parts of the equipment furnished shall, be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.

B. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these Specifications.

C. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.

D. All bearings and moving parts shall be adequately protected by bushings or other approved means against wear, and provision shall be made for accessible lubrication by extending lubrication lines and fittings to approximately 30 inches above finished floor elevation.

E. Details shall be designed for appearance as well as utility. Protruding members, joints, corners, gear covers, etc., shall be finished in appearance. All exposed welds on machinery shall be ground smooth and the corners of structural shapes shall be rounded or chamfered.

F. Machinery parts shall conform within allowable tolerances to the dimensions shown on the working drawings.

G. All machinery and equipment shall be safeguarded in accordance with the safety codes of the USA and the State in which the project is located.

H. All rotating shafts, couplings, or other moving pieces of equipment shall be provided with suitable protective guards of sheet metal or wire mesh, neatly and rigidly supported. Guards shall be removable as required to provide access for repairs.

I. All equipment greater than 100 pounds shall have lifting lugs, eyebolts, etc., for ease of lifting, without damage or undue stress exerted on its components.

J. All manufactured items provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products.

1.06 EQUIPMENT WARRANTIES

A. Warranty requirements may be added to or modified in the individual equipment specifications.

B. The equipment furnished under this Contract shall be guaranteed to be free from defects in workmanship, design and/or materials for a period of one (1) year unless otherwise specified in the individual equipment specifications. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Contractor shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

C. The Contractor shall guarantee to the Owner that all equipment offered under these specifications, or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation, and that he has not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which the Owner as user is likely to be made the defendant.

Where patent infringements are likely to occur, each Contractor shall submit, as a part of his bid, license arrangements between himself, or the manufacturer of the equipment offered, and the patent owner or the controller of the patent, which will permit the use in the specified manner of such mechanical equipment as he may be bidding.

Each Contractor, by submitting his bid, agrees to hold and save the Owner and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for, or on account of, any patented or unpatented

invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by the Owner.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. The materials covered by these Specifications are intended to be equipment of proven reliability, and as manufactured by reputable manufacturers having experience in the production of such equipment. The Contractor shall, upon request of the Engineer, furnish the names of not less than 5 successful installations of the manufacturer's equipment of the same size and model of that offered under this contract. The equipment furnished shall be designed, constructed, and installed in accordance with the industry accepted practices and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturer's recommendations.

### 2.02 ANCHORS AND SUPPORTS

A. The Contractor shall furnish, install, and protect all necessary guides, bearing plates, anchor and attachment bolts, and all other appurtenances required for the installation of the devices included in the equipment specified. Working Drawings for installation shall be furnished by the equipment manufacturer, and suitable templates shall be used by the Contractor when required in the detailed equipment Specifications.

B. Anchor bolts and fasteners shall be furnished in accordance with Section 05050, Metal Fastening, and with the individual equipment Specifications. All anchor bolts shall be a minimum of 1/2-inch diameter. All anchor bolts, handrail bolts, washers, clips, clamps, and fasteners of any type shall be constructed of 316 stainless steel, unless otherwise specified the individual equipment Specifications.

### 2.03 DISSIMILAR METALS

A. All dissimilar metals shall be properly isolated to the satisfaction of the Engineer.

### 2.04 STANDARDIZATION OF GREASE FITTINGS

A. The grease fittings on all mechanical equipment shall be such that they can be serviced with a single type of grease gun. Fittings shall be “Zerk” type.

### 2.05 ELECTRICAL REQUIREMENTS

A. All electrical equipment and appurtenances, including but not limited to motors, panels, conduit and wiring, etc., specified in the equipment specifications shall comply with the applicable requirements of the Division 16 specifications and the latest National Electric Code.

B. Motors shall conform to the applicable requirements of Section 15170, Electric Motors.

C. In the individual equipment specifications, specified motor horsepower is intended to be the minimum size motor to be provided. If a larger motor is required to meet the

specified operating conditions and performance requirements, the Contractor shall furnish the larger sized motor at no additional cost to the Owner.

D. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating with the VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Variable Frequency Drive Systems.

E. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.06 ACCESSORIES, SPARE PARTS, AND SPECIAL TOOLS

A. Spare parts for equipment shall be furnished where indicated in the equipment Specifications or where recommended by the equipment manufacturer.

B. Spare parts shall be identical and interchangeable with original parts.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Painting requirements for spare parts shall be identical to those for original, installed parts. Where no painting or protective coating is specified, suitable provisions shall be made to protect against corrosion.

E. Spare parts shall be delivered at the same time as the equipment to which they pertain. All of these materials shall be properly packed, labeled, and stored where directed by the Owner and Engineer.

F. The Contractor shall furnish all special tools necessary to operate, disassemble, service, repair, and adjust the equipment in accordance with the manufacturers operation and maintenance manual.

G. The Contractor shall furnish a one year supply of all recommended lubricating oils and greases. The manufacturer shall submit a list of at least four manufacturer's standard lubricants which may be used interchangeably for each type of lubricant required. All of these materials shall be properly packed, labeled and stored where directed by the Engineer.

2.07 EQUIPMENT IDENTIFICATION

A. All mechanical equipment shall be provided with a substantial stainless steel nameplate, mechanically fastened with stainless steel hardware in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

B. Each pump and other piece of mechanical equipment shall also be identified as to name and number by a suitable laminated plastic or stainless steel nameplate mechanically fastened with stainless steel hardware; for example, "Raw Water Pump #1". Coordinate name and number with same on remotely located controls, control panel, and other related equipment.

C. Nameplates shall not be painted over.

## PART 3 -- EXECUTION

### 3.01 SHOP TESTING

A. All equipment shall be tested in the shop of the manufacturer in a manner which shall conclusively prove that its characteristics comply fully with the requirements of the Contract Documents and that it will operate in the manner specified or implied.

B. No equipment shall be shipped to the project until the Engineer has been furnished a certified copy of test results and has notified the Contractor, in writing, that the results of such tests are acceptable.

C. Five (5) certified copies of the manufacturer's actual test data and interpreted results thereof shall be forwarded to the Engineer for review.

D. If required by the individual equipment Specifications, arrangements shall be made for the Owner/Engineer to witness performance tests in the manufacturer's shop. The Engineer shall be notified ten working days before shop testing commences. Expenses are to be paid by Owner.

E. Shop testing of electric motors shall be in accordance with applicable requirements of Section 15170, Electric Motors and Section 16000, Basic Electrical Requirements.

### 3.02 MANUFACTURER'S FIELD SERVICES

A. The Contractor shall arrange for a qualified Technical Representative from each manufacturer or supplier of equipment who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of the specified equipment. Qualification of the Technical Representative shall be appropriate to the type of equipment furnished and subject to the approval of the Engineer and the Owner. Where equipment furnished has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment. When necessary, the Contractor shall schedule multiple Technical Representatives to be present at the same time for the purpose of coordinating the operation of multiple pieces of related equipment.

B. For each site visit, the Technical Representative shall submit jointly to the Owner and the Engineer a complete signed report of the results of his inspection, operation, adjustments, and testing. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified.

C. The Contractor shall provide the following services.

1. Installation: The Contractor shall inspect the installed equipment to verify that installation is in accordance with the manufacturer's requirements. Where required by individual equipment specifications, the Contractor shall also supervise the installation of the equipment.

2. Testing: After installation of the equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the Contractor shall inspect, operate, test, and adjust the equipment as required to prove that the equipment is in proper condition for satisfactory operation under the conditions specified. Unless otherwise noted in the signed site visit report, the report shall constitute a certification that the equipment conforms to the requirements of the Contract and is ready for startup and that nothing in the installation will render the manufacturer's warranty null and void. The report shall include date of final acceptance field test, as well as a listing of all persons present during tests.

3. Startup: The Contractor shall start up the equipment for actual service with the help of the Contractor. In the event that equipment or installation problems are experienced, the Contractor and the representative shall provide the necessary services until the equipment is operating satisfactorily and performing according to the specifications at no additional cost to the Owner. Unless otherwise noted in the signed site visit report, the report shall constitute a certification 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.

4. Training: The Contractor shall instruct the Owner's operating personnel in correct operation and maintenance procedures. The instruction shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. Such instruction shall be scheduled at a time arranged with the Owner at least 2 weeks in advance of the training and shall be provided while the respective Contractor's equipment is fully operational. The Contractor shall have submitted, and had accepted, the O&M Manuals prior to commencement of training. Training shall be provided to three separate shifts of the Owner's personnel between the hours of 8:00 A.M. and 6:00 P.M. as necessary. The Contractor shall provide professional video taping of all training sessions. Completed, labeled tapes shall be provided to the Owner for each type of training session.

5. Services after Startup: Where required by the individual equipment specifications, the Contractor shall return to the project site thirty (30) days after the start up date to review the equipment performance, correct any equipment problems, and conduct operation and maintenance classes as required by the Owner. This follow-up trip is required in addition to the specified services of Contractor prior to and during equipment startup. At this time, if there are no equipment problems, each manufacturer shall certify to the Owner in writing that his equipment is fully operational and capable of meeting operating requirements. If the equipment is operating incorrectly, the Contractor will make no certification to the Owner until the problems are corrected and the equipment demonstrates a successful thirty (30) days operating period.

D. Services of the Contractor will require a minimum of two (2) site visits, one for installation and testing and one for startup and training, and will be for the minimum number of days recommended by the manufacturer and approved by the Engineer but will not be less than the number of days specified in individual equipment sections.

E. The Contract amount shall include the cost of furnishing the Contractor for the minimum number of days specified, and any additional time required to achieve successful installation and operation. The times specified for services by the Contractor in the equipment Specifications are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

F. The Contractor shall notify the Engineer at least 14 days in advance of each equipment test or Owner training session.

G. The Contractor shall sign in and out at the office of the Resident Project Representative on each day he is at the project.

3.03 INSTALLATION

A. The Engineer shall obtain written installation manuals from the Contractor prior to installation. Equipment shall be installed strictly in accordance with recommendations of the manufacturer. A copy of all installation instructions shall be furnished the Engineer's field representative one week prior to installation.

B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.

C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.

D. All equipment sections and loose items shall be match-marked prior to shipping.

E. For equipment such as pumping units, which require field alignment and connections, the Contractor shall provide the services of the manufacturer's qualified mechanic, millwright, or machinist, to align the pump and motor prior to making piping connections or anchoring the pump base. Alignment shall be as specified herein.

F. The Contractor shall furnish oil and grease for initial operation and testing. The manufacturer and grades of oil and grease shall be in accordance with the recommendations of the equipment manufacturer.

- END OF SECTION -

SECTION 11100

PUMPS - GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish all pumping equipment, complete with all necessary accessories, in compliance with the Contract Documents.

B. All pumping equipment shall be provided in accordance with the requirements of Section 11000, Equipment General Provisions.

C. The provisions of this section shall apply to all pumps and pumping equipment specified except where specifically noted otherwise in the Contract Documents.

D. The pumps shall be provided complete with all accessories, shims, sheaves, couplings, and other appurtenances as specified, and as may be required for a complete and operating installation.

1.02 SHOP DRAWINGS

A. Shop Drawings shall include the following information in addition to the requirements of Section 01300, Submittals and Section 11000, Equipment General Provisions.

1. Details of shaft sealing system

2. Pump performance curves at rated speed and reduced speed (if reduced speeds are specified). Curves shall indicate flow, head, efficiency, brake horsepower, NPSH required, and minimum submergence. Curves shall include limits (minimum and maximum flows) for stable operation without cavitation, overheating, recirculation, or excessive vibration.

3. General cutaway sections, materials, dimension of shaft projections, shaft and keyway dimensions, shaft diameter, dimension between bearings, general dimensions of pump, suction head bolt orientation, and anchor bolt locations and forces.

4. Foundry certificates and results of Brinnell hardness testing showing compliance to ASTM A 532 (where required in the individual pump specifications).

5. Submersible pump submittals shall also include:

a. Product data sheets for power and control cables and length of cables.

b. Details on pump guide rail system and mounting requirements.

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PART 2 -- PRODUCTS

2.01 MATERIALS

A. All materials employed in the pumping equipment shall be suitable for the intended application. All materials shall conform with the “Federal "Reduction of Lead in Drinking Water Act". Material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended, and shall conform to the following requirements unless otherwise specified in individual pumping equipment Specifications:

1. Cast iron pump casings and bowls shall be of close-grained gray cast iron, conforming to ASTM A 48, or equal.

2. Bronze pump impellers shall conform to ASTM B 584, “G” tin bronze.

3. Stainless steel pump shafts shall be of Type 400, Series. Miscellaneous stainless steel parts shall be of Type 316.

4. Column pipe bearing retainers shall be bronze metal

B. Suction and discharge flanges shall conform to ANSI standard B16.1 or B16.5 dimensions.

C. Handholes on pump casings shall be shaped to follow the contours of the casing to avoid any obstructions in the water passage.

2.02 APPURTENANCES

A. Pressure Gauges

1. The Contractor shall furnish and install pressure gauges on the suction and discharge of each pump, except wet-pit submersible and vertical turbine pumps.

2. The Contractor shall furnish and install pressure gauges on the discharge piping of each wet-pit submersible pump and vertical turbine pump in the locations shown on the Drawings or as directed by the Engineer.

3. Suction gauges shall be of the single scale compound type to indicate both pressure and vacuum. Each suction gauge shall be graduated in feet of water over the span of 34 feet below and above zero.

4. Discharge gauges shall be graduated in feet from zero to a minimum of five (5) feet of water above the respective pump shutoff head or to a minimum of 30% above the maximum operation pressure, whichever is greater. Graduation shall be in feet of water.

5. All gauges shall be supplied by one manufacturer and shall be as specified in Section 17650, Pressure Gauges.

6. All gauges shall be provided with diaphragm seals or isolating ring seals as specified in Section 17698, Instrumentation and Control Accessories.

B. Flexible couplings for direct driven pumps shall be as manufactured by Falk, Dodge, Woods Corp., or equal and shall be furnished with guards in accordance with OSHA Rules and Regulations. Spacer couplings shall be provided where necessary to allow removal of the pump rotating element without disturbing the driver.

2.03 ELECTRICAL REQUIREMENTS

A. All pumps shall be furnished with motors such that the motor shall not be overloaded throughout the full range of the pump operation, unless otherwise specifically approved by the Engineer.

B. Where variable frequency drives (VFDs) are specified, the Contractor shall be responsible for coordinating with the VFD supplier to ensure a complete and operational system. VFDs shall be furnished under Division 16 and shall be as specified in Section 16495, Variable Frequency Drive Systems.

C. Motor starters and controls shall be furnished and installed under Division 16 and Division 17 unless otherwise specified in the individual pump specifications.

2.04 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of Section 11000, Equipment General Provisions, nameplate data for each pump shall include the rating in gallons per minute, rated head, speed, and efficiency at the primary design point.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Drains: All gland seals, air valves, and drains shall be piped to the nearest floor drain or trench drain with bronze pipe or copper tube, properly supported with brackets.

B. Solenoid Valves: Where required, the pump manufacturer shall furnish and install solenoid valves on the water or oil lubrication lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be furnished complete with all necessary conduit and wiring installation from control panel to solenoid.

3.02 SHOP TESTING

A. Shop tests shall be performed in accordance with Section 11000, Equipment General Provisions, and except where stated otherwise herein, shall be conducted in accordance with applicable methods and standards of the American National Standard for Centrifugal Pump Tests by the Hydraulic Institute.

B. Pump testing shall be witnessed by the Owner/Engineer where specified in the individual pump specifications. The testing procedure shall be submitted to the Engineer for review before scheduling the testing. The Engineer shall be given at least 2 weeks advanced notice of the scheduled testing date.

C. Certified test curves for shall be provided for all centrifugal pumps unless otherwise specified in the individual pump specifications. Certified tests will not be required for submersible sump pumps with motors less than 5 hp

D. Pumps shall be within the tolerances specified by the Hydraulic Institute Standards with the following exceptions:

1. At design heads, +10% of design capacities or at design capacities, +5% of design heads.

2. No minus tolerances shall be allowed with respect to capacity, head, or efficiency at the design points.

E. For wet pit submersible pumps and vertical turbine pumps, all tests shall be run at minimum pump submergence specified in the individual pump specifications.

F. Where required in the individual pump specifications, each individual casting shall be Brinnell tested in a minimum of two places, in an area of representative casting thickness to ASTM Method E-10. Results shall be certified by a registered professional Engineer. Test results shall verify the satisfaction of the required Brinnell hardness of the finished product as specified in respective subsections.

- END OF SECTION -

SECTION 11153

VERTICAL TURBINE PUMPS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Sub-Contractor shall furnish, paint, test, and make fully operational all pumping equipment, complete with all necessary accessories, in compliance with the following Specifications, Section 11000, Equipment General Provisions, Section 11100, Pumps, General, 15170, Electric Motors, 16495, Variable Frequency Drives.

B. The pump shall be provided complete with all accessories, shims, sheaves, couplings and other appurtenances as specified and as may be required for a complete and operating installation. All pump equipment that comes into contact with finished water shall be NSF 61 approved materials for use in drinking water applications. Pump motors shall be supplied by the pump manufacturer.

C. Vertical turbine pumps shall be designed to pump finished water as designated below. All pumps shall have an above deck discharge configuration as shown on the Contract Drawings.

D. The vertical turbine pump supplier shall provide under its scope of supply a variable frequency drive (VFD) fully compatible with the pump and motor supplied. Performance requirements for both VFD and pump shall rest with the pump supplier.

D. The following is a list of pumping equipment to be provided under this Section:

| Pump Designation | Pump Service | Work to Include |
|---|---|---|
| BWP– 1 and BWP-2 | Backwash Pump No. 1 and No. 2 | New Pumps and Motors |

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300 – Submittal

B. Section 09900 – Painting

C. Section 11000 – Equipment General Provisions

D. Section 11100 – Pumps - General

E. Section 15170 – Electric Motors

F. Section 16495 – Variable Frequency Drives

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes and Standards

1. All items to come in incidental contact with drinking water shall demonstrate conformance to the applicable American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 or 61; or Underwriter Laboratory (UL) standards.

2. Federal "Reduction of Lead in Drinking Water Act" – 2011

B. Commercial Standards

1. ASTM - American Society for Testing Materials

2. ANSI - American National Standards Institute

3. Hydraulic Institute Standards

4. NEMA - National Electrical Manufacturer's Association

1.04 SUBMITTAL

A. The Sub-Contractor shall submit Shop Drawings, Operation and Maintenance Instructions and other information as specified in accordance with Section 11000, Equipment General Provisions, Section 11100, Pumps - General, Section 15170, Electric Motors, and Section 01300, Submittals. Additional required information shall include: the horsepower, voltage, full load amps and rotative speed of the motor and the total weight of the shipped materials. Pump manufacturer shall design and detail of pump can. Shop Drawings shall include complete erection, installation and adjustment instructions and recommendations along with Operations and Maintenance Manuals.

B. The pump manufacturer shall submit calculations on the design of the pump subbase plate for supporting and anchoring the pumps. Calculations shall include manufacturer’s input values for pump weight, thrust forces, torsion forces and other factors that determine subbase plate thickness for Design Builder review.

1.05 MANUFACTURER’S RESPONSIBILITY

A. The Manufacturer shall provide the services of a qualified technical representative from the pump and shafting suppliers with at least three (3) years of experience and regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of vertical turbine pumps. This individual shall adequately supervise the installation and testing of all equipment furnished under this Contract and shall instruct the Owner's operating personnel in its maintenance and operation as outlined in Section 11000, Equipment General Provisions and Division 1.

The Manufacturer's technical representatives shall:

1. Witness and check installation of pumps, motors, and shafting.

2. Assist the Design Builder in conducting field tests and preparing a written report as specified below.

3. Witness and check start-up of the system.

4. Monitor vibration of pumps, motors, and intermediate shafting through the complete range of operating speeds with proper diagnostic equipment and at full running speed of 1800 rpm the velocity shall not exceed 0.1 inches/sec RMS unfiltered.

5. Assist the Contractor in making adjustments and modifications as necessary to optimize performance and to minimize vibration and wear. Vibration adjustments to the pumping system shall conform to the limits established American Water Standard of 0.1 inches /sec RMS, unfiltered at 1800 rpm.

6. Troubleshoot and correct any mechanical or control problems encountered during tests and start-up.

7. Submit written certification that the equipment has been properly installed, tested, and adjusted; that the system operates as specified or as required; and that all controls and protective devices operate properly, including date of final acceptance test, and a list of all persons present during the tests. Baseline vibration data shall be collected and furnished as part of this written certification

8. Investigate and supervise correction of any operating problems which may arise - up to the end of the guarantee period of the equipment.

9. Instruct Owner personnel in the operation and maintenance of equipment.

B. The services of the Manufacturer’s technical representative shall be provided for a period of not less than two (2) days for each pump as follows:

1. At least one trip of one (1) day to check and supervise the equipment installation for each pump.

2. One trip of one (1) day to supervise initial start-up and operation, to perform field tests, and to instruct the Owner’s personnel in proper operation and maintenance of the equipment.

C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.

D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

1.06 WARRANTY

A. The Manufacturer shall guarantee the pumps and associated equipment for a period of one (1) year against defects in materials or workmanship and against problems

attributable to ordinary wear under normal operation of the equipment. The warranty shall be in accordance with Division 1 of the Specifications.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. All vertical turbine pumps, including bowls, suction column and discharge head assemblies, for the project shall be provided by Floway or Flowserve, no exceptions.

### 2.02 MATERIALS

A. Pump bowls shall be of close grained cast iron, ASTM A48, Class 30 or higher grade. Castings shall be free from blow holes, sand holes, and all other defects and shall be accurately machined and fitted to close dimensions. All water passages shall have a Scotchkote 134 fusion bonded epoxy coating, acceptable for use with potable water. Bowl bushings shall be bronze-backed rubber and bolts shall be 316 stainless steel. All materials shall be NSF 61 approved.

B. The impeller shaft shall be of 416 stainless steel and shall be supported by bronze bearings located on the upper and lower end of each impeller. Bearings shall be potable water lubricated except that suction bowl bearings may be permanently packed, grease lubricated.

C. Impellers shall be of the enclosed type as required to meet the specified performance requirements of 316L stainless steel and shall be accurately fitted and hydraulically and dynamically balanced. The shafts shall be secured with a thrust washer, key and snap ring, or other approved means. The impellers shall be designed with smooth passages to assure efficient operation. They shall be furnished with replaceable bowl and impeller wear rings. No underfiling of impellers shall be allowed.

D. Wear rings shall be provided to maintain pump efficiency. Wear rings shall be designed so as not to loosen during any condition of operation or handling, including reverse rotation of the pump. Impeller wear ring shall be 410 stainless steel and of Brinell Hardness 200-250 minimum. Bowl wear rings shall be 420 or 410 stainless steel and shall be of Brinell Hardness 300-350.

E. The pump column pipe shall be carbon steel, AWWA Standard Wall Pipe. Pipe shall be flanged and furnished in sections not over ten feet in length. Bolts for flanged column pipe shall be stainless steel.

F. The line shafting and lineshaft couplings shall be 416SS turned, ground, solid shaft and polished precision shafting of ample size to operate the pump without distortion or vibration. The shaft shall be furnished in interchangeable sections not over ten feet in length and shall be coupled with 416 stainless steel couplings. Lineshafts and coupling to be ground and polished to a finish not to exceed RMS 40 (ANSI B 46.1). All lineshaft and couplings to be configured with threaded connections. The lineshafts and couplings shall have a potable water-lubricated rubber bearing. The shaft connections and bearings shall provide accurate shaft alignment. Pump shall be water lubricated with open lineshaft.

G. New pump discharge heads shall be comprised of three-segment, two-45° bend construction, discharging the vertical pump suction in the horizontal plane parallel with the finished floor. The discharge head shall be furnished and located at the elevations indicated on the Contract Drawings. The discharge head shall be tapped and plugged for a ½-inch NPT pressure gauge connection and a 6-inch air/vacuum release valve connection located as shown on the Contract Drawings. Discharge heads shall be cast iron ASTM A-48 Class 30 alloy or fabricated steel (ASTM A36) with shoulder joint discharge connections per ANSI/AWWA C606.

A carbon steel motor to pump coupling assembly shall be provided for each pump.

H. Shaft seal for distributive and backwash pumps and motor shafts shall utilize single balanced cartridge mechanical seals. The stator shall be carbon and the rotor silicon carbide. All metal parts shall be constructed of 316 stainless steel and the springs be Hastelloy C. All secondary seals shall be Viton or EPR. The split seals shall be as manufactured by Durametallic or John Crane, Inc.

I. Subbase plates (soleplates) shall be provided for the pump with the required dimensions for mounting of the driver and discharge head to the steel casing. Subbase plates shall be cast iron or fabricated steel, designed by the pump manufacturer.

J. Each pump shall be furnished with one (1) upper bearing RTD, one (1) lower bearing RTD, and one (1) pump casing RTD. RTDs shall be 100 ohm, platinum, 3 wire type and shall be suitably mounted to the pump by the pump manufacturer.

2.04 PUMP CANS

A. Cans shall be fabricated of Type 316L stainless steel and be pressure rated for 150 psig.

B. Provide a flange at the top of the pump can so the pump discharge head can be bolted onto the can. Pressure rating of the pump can top flange shall be the same as the suction flange. Flanges shall be flat face. Gaskets shall be fullface, 1/8-inch thick, and shall be one of the following nonasbestos materials:

1. Cloth-inserted rubber. Products: Manville No. 109, John Crane Co. Style 777, or equal. Gaskets shall be suitable for a pressure of 350 psi at a temperature of 180 F.

2. Acrylic or aramid fiber bound with nitrile. Products: Garlock “Bluegard”, Klinger “Klingersil C4400”, or equal. Gaskets shall be suitable for a water pressure of 500 psi at a temperature of 400 F.

C. Bolts and nuts for flanges shall be Type 316 stainless steel, conforming to ASTM A 193 (Grade B8M) for bolts and ASTM A 194 (Grade 8M) for nuts.

D. Welding shall conform to the following:

1. Fabrication shall be in accordance with ANSI B31.3, Chapter V. Welding procedures and performance qualifications shall be in accordance with the ASMI Boiler and Pressure Vessel Code.

2. The minimum number of passes for welded joints shall be as follows:

| Steel Cylinder Thickness (inch) | Minimum Number of Passes for Welds |
|---|---|
| Less than 0.1875 | 1 |
| 0.1875 through 0.25 | 2 |
| Greater than 0.25 | 3 |

3. Welds shall be full circumferential.

4. Use the shielded metal arc welding (SMAW) process.

5. Welding preparation shall comply with ANSI B31.3, paragraph 328.4. Limitations on imperfections in welds shall conform to the requirements in ANSI B31.3, Tables 341.3.2A and 341.3.2B, and paragraph 341.4 for visual examination.

6. Clean each layer of deposited weld metal prior to depositing the next layer of weld metal, including the final pass, by a power-driven wire brush.

7. Welding rod shall comply with AWS A5.1.

E. Beveled ends for butt welding shall conform to ANSI B16.25. Remove slag by chipping or grinding. Surfaces shall be clean of paint, oil, rust, scale, slag, and other material detrimental to welding.

F. Test the seams by the dye-penetrant method per ASTM E 165, Method B.

G. Test pump cans at the place of manufacture per the referenced ASTM standards for the pipe.

H. The Contractor shall coordinate pump installation requirements with the manufacturer to ensure a vibration free and stable installation.

I. The manufacturer shall have unit responsibility for coordinating and fabricating the proper pump mounting design for the layout shown on the drawings. If, in the opinion of the manufacturer, the openings or other aspects of the pump mounting design must be revised to allow for vibration free, stable pump operation, the manufacturer shall submit said revisions to the Engineer for review, comment and acceptance. The manufacturer shall then be responsible for implementing such revisions at no additional cost. Can length shall be a minimum of 4 times the can diameter. Can shall be equipped with straightening vanes in accordance with the Hydraulic Institute.

## 2.05 ELECTRIC MOTORS

A. Electric motors for all pumps shall be provided by the pump manufacturer. The Manufacturer shall be responsible for providing all necessary motor dimensions, weight, nameplate information, and any other required motor information.

B. The pump horsepower required for any point on the pump characteristic curve shall not exceed the rated motor horsepower.

C. The pump manufacturer shall provide an electric motor in accordance with Section 15170 –Electric Motors.

D. Electrical Requirements:

**Backwash Pump No. 1 and No. 2**

| | |
|---|---|
| Motor Type | Direct Coupled- Vertical |
| Rating | 460V, 3 ph, 60 Hz |
| Horsepower | 140 |
| Speed, rpm | 1200 rpm |
| Enclosure | TEFC |
| Insulation | Class H |
| Inverter Duty | Yes |
| Service Factor | 1.15 |
| Space Heater | Yes, 120 V, 1 Phase |
| Motor Winding Thermal Switches | Yes |
| Motor Winding RTDs | No |
| Upper and Lower Motor Bearing RTDs | No |
| Separate Cooling Fan | No |
| Motor Speed Control | Variable Frequency Drives |
| Motor Shaft | Hollow Shaft |

E. Motor winding temperature detection shall be accomplished via temperature switches embedded in the motor windings. The detectors shall be placed at locations determined to give close approximation of the hottest spot temperatures. Motor winding temperature switches shall be factory wired to a separate gasketed terminal box on the motor frame.

F. A shaft grounding ring shall be provided to shunt induced shaft noise to ground and minimize electrical discharge bearing damage due to operation on variable frequency drives. Provide Aegis grounding ring or equal.

2.06 PERFORMANCE REQUIREMENTS

A. When operating at the maximum output speed each pump shall have a characteristic performance curve which meets all the minimum conditions listed in the pump schedule. The pumps and drive motors shall be capable of operating satisfactorily under the full-range of speed, flow and pressure conditions as defined by the pump schedule. Pump efficiency as defined herein shall include all losses from the pump intake suction bell to the pump discharge flange.

B. Pump Operating Conditions

| Description | Backwash Pumps No. 1 and No. 2 |
|---|---|
| 1. Maximum Pump Operating Speed (rpm) | 1,180 |
| 2. Number of Stages | 1 |
| 3. Operating Point No. 1 (at max pump speed): | |
| a. Flow (gpm) | 2,500 |
| b. Total Head plus or minus 5 feet (feet) | 64.0 |
| 4. Operating Point No. 2 (Design) (at max pump speed): | |
| a. Flow (gpm) | 9,933 |
| b. Total Head (feet) | 35.5 |
| 5. Operating Point No. 3 (at max pump speed): | |
| a. Flow (gpm) | 15,000 |
| b. Total Head plus or minus 5 feet (feet) | 22.0 |
| 6. Operating Point at Turndown: | |
| a. Flow (gpm) | 2,483 |
| b. Total Head plus or minus 5 feet (feet) | 4.7 |
| 6. Minimum Submergence (in.) | TBD |
| 7. Maximum NPSH Required at Operating Point No. 2 (feet) | TBD |
| 8. Shaft Type | Open, Potable Water Lubricated |
| 9. Sub-base Plate (sole plate): | Yes |
| 10. Discharge Diameter (inches) | 18 |
| 11. Minimum Column Diameter (inches) | 16 |
| 12. Baseplate to Centerline of Discharge Pipe (inches) | TBD |

PART 3 -- EXECUTION

3.01 SHOP TESTS

A. Shop tests shall be performed in accordance with the following Specifications: Section 11100, Pumps - General and, except where stated otherwise herein, the Hydraulic Institute Standards. Certified pump test curves for each pump is required. Tolerances shall be within those specified by the Hydraulics Institute Standards.

B. Design Builder witnessed performance tests shall be conducted for Backwash and Distributive Water pumps. The Owner shall pay for Design Builder and Owner travel and time for the initial witness test. The Sub-Contractor shall pay for Design Builder and Owner travel and time for subsequent visits required due to failure of initial witness test. Shop tests for these pumps shall be performed with vortex suppressor installed on the pump. Preliminary tests shall be performed and test results forwarded, along with certified

hydrostatic test results, in good time, to the Design Builder prior to the witnessed testing. Hydrostatic tests need not be witnessed.

C. The preliminary pump test results shall indicate that all pumps meet or exceed the specified performance conditions. Performance tolerance shall meet Level of Acceptance A as specified in Section 1.6 of the Hydraulic Institute Standards. Pump manufacturer shall measure vibration in accordance with the Hydraulic Institute Standards and include results in the report to the Engineer.

D. If preliminary testing indicates that modifications are required to the equipment or test facilities, all such modifications shall be carried out prior to the witnessed shop tests and revised performance testing. Contractor shall provide the Engineer with a minimum of 30 days advance notice of the witnessed test schedule. Upon satisfactory completion of the witnessed tests, certified pump test curves shall be prepared as indicated herein and forwarded to the Engineer for his final approval.

E. Net positive suction head required (NPSHR) shall be tested at the runout point (third design point at high flow/low head condition) at the field minimum water level during the preliminary testing. It is not required that testing for NPSHR be performed during witness testing. Test data shall be measured and recorded in accordance with the Hydraulic Institute test procedures. Results shall be corrected as required to the specified operating conditions and shall be plotted in the standard format.

3.02 INSTALLATION

A. The equipment shall be installed by the Design Builder in accordance with the Contract Drawings and the instructions and drawings of the manufacturer, Section 11000, Equipment-General, and Section 11100, Pumps – General, including furnishing oil and grease for operation. The manufacture and grades of oil and grease shall be in accordance with the recommendations of the pump manufacturer.

B. The location of the pump suction and pump can shall conform to recommendations of the pump manufacturer.

3.03 FIELD TESTS

A. Field tests shall be made in accordance with Section 11000, Equipment General Provisions, Section 11100, Pumps - General, and Division 1. Preliminary field tests shall be made as soon as possible after installation of the pumps. Final acceptance tests shall demonstrate the following:

1. That the pumps have been properly installed and are in proper alignment.

2. That the pumps operate without overheating or overloading of any parts and without objectionable vibration. Pump shall meet requirements and procedures for Vibration Measurements and Allowable Values as specified in Section 9.6.4 of the Hydraulic Institute Standards.

3. That there are no mechanical defects in any of the parts.

4. That the pumps can meet the specified operating conditions.

3.04 PAINTING

A. All surface preparation, shop painting, field repairs, finish painting and other pertinent detailed painting specifications shall conform to applicable sections of Section 09900, Painting.

B. Surfaces that will be exposed after installation shall be painted as specified in Section 09900 – Painting. The exterior and interior of the column pipe and the bowl shall be coated as specified in Section 09900. Refer to Paragraph 2.02 Materials, for bowl interior coatings. All paints that come into contact with finished water shall be NSF 61 approved.

C. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.05 EQUIPMENT IDENTIFICATION

A. The pumps shall be provided with a substantial stainless steel nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data. Nameplate data shall include the rating in gallons per minute, rated total dynamic head, rotation direction, motor speed, and efficiency for the designated design point.

3.06 MOTOR STARTERS, CONTROLS AND INSTRUMENTATION

A. Motor starters and controls shall be furnished as specified in Division 16, Electrical and Division 17, Control and Instrumentation Systems.

- END OF SECTION -

SECTION 11280

POSITIVE DISPLACEMENT BLOWER PACKAGE

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish one (1) positive displacement blower packages. The blower package shall be provided for filter air scour and shall consist of one (1) positive displacement blower housed in a close-fitting acoustical enclosure complete with all accessories including motors, steel bases, inlet filters, inlet silencers, discharge silencers, pressure relief valves, check valves, butterfly valves, pressure gauges, flexible connectors, V-belt drives, belt guards, vibration isolation, and other components for a complete blower package as shown on the Contract Drawings and as specified herein.

B. Contractor shall relocate existing air scour blower from current location near the existing filter building to the new location north of the new filter building. The existing enclosure shall be reused. A new motor shall be provided and installed within the existing enclosure. Contractor shall be responsible for all electrical and piping connections required to return the relocated blower to service in its new location.

C. Blowers shall be as furnished by Kaeser, no exceptions.

### 1.02 SUBMITTALS

A. In addition to the submittal requirements specified in Section 01300 - Submittals and Section 11000 - Equipment General Provisions, submit the following:

1. Complete shop drawings and operation and maintenance manuals.

2. Support locations and loads that will be transmitted to bases and foundations. Weights of all system components and the total weight of the operating blowers.

3. Complete electrical field termination drawings.

4. Electrical equipment product data sheets.

5. Overall equipment layout and piping interconnection drawings.

6. Copies of certified shop test reports.

7. Field test results.

### 1.03 OPERATION AND MAINTENANCE MANUALS

A. Furnish Operation and Maintenance manuals, shop drawings and other material required as specified in Section 01300 and Section 11000.

B. The Contractor shall submit a complete list of additional spare parts beyond those specified herein, which the manufacturer recommends to be kept on hand and as specified in Section 11000.

1.04 CONTRACTOR'S RESPONSIBILITY

A. The Manufacturer shall provide the services of qualified service persons with at least five (5) years of experience who are regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of positive displacement blower systems. The service persons shall:

1. Witness and check installation.

2. Assist the Contractor in conducting field tests and preparing a written report as specified below.

3. Witness and check start-up of the system.

4. Assist the Contractor in making adjustments and modifications as necessary to optimize operation of system components.

5. Troubleshoot and correct any mechanical or control problems which are noted during tests and start-up.

6. Submit written certification that the system has been properly installed, tested, and adjusted; and that all controls and protective devices operate properly, including date of final acceptance test, as well as a listing of all persons present during the tests.

7. Investigate and supervise correction of any operating problems which may arise up to the end of the guarantee period of the equipment.

8. Instruct Owner personnel in the operation and maintenance of the equipment.

B. The services of a qualified manufacturer's technical representative shall be provided at no additional cost to the Owner for a period of not less than two (2) days as follows:

1. At least one trip of one (1) day during installation of the equipment.

2. At least one trip of one (1) day after acceptance of the equipment for start-up purposes.

C. Any additional time required to achieve successful installation and operation shall be at the expense of the Manufacturer.

1.05 FACTORY TESTING

A. After assembly, each blower system shall be factory lubricated, aligned and operationally tested. Run time on each blower shall be at least one (1) hour after which each blower shall be rechecked for alignment and tension of V-belts and adjusted if necessary. If adjustments are made, the blower(s) shall be restarted and run an additional 15 minutes, shut down and rechecked again.

B. A report on each blower system, shall be furnished with the O&M manuals giving as a minimum the following readings taken at/or near the end of the one hour run time:

1. Motor current, per phase.

2. Applied motor voltage, phase-to-phase

3. Discharge pressure, psi

4. Air Flow, scfm

5. Surface temperatures of motor bearings and blower bearings and blower discharge air.

6. Blower discharge air temperature

7. Noise level in dbA measured at 3 ft from the blower system in the following six (6) locations: one on each short side of the blower, and two on each long side of the blower.

8. Vibration levels in inch/second of blower and motor bearing housing in horizontal, vertical and axial direction and in six (6) locations specified for noise level measurement, but on the common base.

## PART 2 -- PRODUCTS

### 2.01 EQUIPMENT REQUIREMENTS

A. The Contractor shall furnish one (1) positive displacement blower packages complete with all accessories. Each blower shall provide 1,300 scfm at 5.8 psig discharge pressure at the following local conditions:

| | |
|---|---|
| Maximum inlet temperature | 105$^{o}$F |
| Maximum relative humidity | 90% |
| Elevation | 1000’ above MSL |

Blower speed shall be a maximum of 1625 rpm. Blower motor horsepower shall be 60 horsepower. Blower discharge pressure specified above is the required pressure downstream of the discharge isolation butterfly valve. Blower manufacturer shall be responsible for design of the blower for inlet losses and discharge losses including the discharge isolation valve. Blower speed shall not exceed 80% of the recommended maximum speed for the selected blower.

B. The blower casing shall be of one piece with separate headplates, and shall be made of close-grained cast iron suitably ribbed to prevent distortion under the specified operating conditions.

C. Each lobe shall be made from a ductile iron casting. Shafts shall be alloy steel forgings. The lobes shall be of the straight, tri-lobe involute type and shall operate without rubber

C. Each lobe shall be made from a ductile iron casting. Shafts shall be alloy steel forgings. The lobes shall be of the straight, tri-lobe involute type and shall operate without rubber or liquid seals or lubrication and shall be positively timed by a pair of accurately machine heat-treated allow steel, helical tooth timing gears. The timing gears shall be mounted on the lobe shafts with a press fit and keyed. One gear shall be equipped with a hub and a gear to facilitate accurate and easy timing. Each lobe/shaft shall be supported by cylindrical roller bearings sized for a minimum of 100,000 hours B-10 life.

D. The lube oil system shall be supplied with sight glasses and ample oil reservoir capacity. Piston ring oil seal shall be provided at each bearing, designed to prevent lubricant from leaking into the air stream. Rotary piston ring shaft seals shall be provided at the point where the shaft passes through the head plate (air seal). A total of 16 piston ring seals are to be provided for each blower. Further provision shall be made to vent the rotor side of the air seal to atmosphere to eliminate carryover of lubricant into the air stream. Lip seals inside the blower are not acceptable. Lip seal is allowed at the drive shaft only complete with wear sleeve.

E. The timing gears and the bearings shall be splash oil lubricated from oil slingers mounted on the driven shaft and dipping in oil. Grease lubricated bearings are not acceptable. To further reduce oil leaks, each bearing must be equipped with an oil deflector disc.

F. Each blower must be provided with stiffener ribs and heavy-duty casings, end plates and reinforced inlet and discharge flanges, so that blowers can be directly mounted on the base without using blower feet.

G. Each blower shall be given a factory mechanical test to assure mechanical integrity. If the test indicates that adjustments are necessary to insure conformance to the manufacturer's standards, such adjustments shall be made prior to shipment.

H. A welded steel fabricated base discharge silencer combination shall be provided for each blower. The base shall support the blower and a pivoting frame supporting the motor. The motor shall be mounted on the pivoting base complete with (2) springs to fine tune belt tension. The complete blower package shall be designed for placement inside an acoustical enclosure. Blower noise level <u>without</u> the acoustical enclosure shall be a maximum of 95 dbA within three feet of the blower. Installation shall conform to recommendations of the blower and V-belt components including motor, V-belt drive, guard, controls, and all necessary items.

I. The motors shall be TEFC suitable for 460V, 3-phase, 60 Hz operation. Motors shall include three normally closed temperature switches embedded in the motor windings. Motor base shall be capable of sliding on the pivoting shaft for proper sheave alignment. Motors shall provide minimum efficiencies and power factors as follows:

| | 60 Horsepower Motor | |
|---|---|---|
| Percent of Full Load | Minimum Efficiency | Minimum Power Factor |
| 100 | 95 | 84 |
| 75 | 96 | 82 |
| 50 | 95 | 75 |

J. Ten inch diameter inlet air filter/silencers shall be provided on the inlet of each blower. Inlet filter/silencer shall include sound absorbing materials. Inlet air filter shall be rated and sized to filter 150% of the maximum calculated airflow at specified local conditions. Filter element shall be immediately upstream of the blower inlet so no foreign materials enter the blower. Filter element shall be removable without the use of any tools. With the filter element removed, clear view of the blower rotors shall be provided.

K. Inlet and outlet expansion joints shall be provided for each blower constructed of synthetic elastomer with split steel retaining rings suitable for the pressure and vacuum service conditions and rated for 300°F continuous service. Outlet expansion joints shall be of the single wide arch design to allow ¾-inch of lateral movement, and shall be located inside the acoustical enclosure.

L. Pressure relief valve shall be provided for each blower. Pressure relief valve shall be installed as close to the blower discharge as feasible but outside of the acoustical enclosure. The pressure relief valve shall have an initial set pressure 1.0 psi over the specified design operating pressure. Pressure relief valve shall be weighted type relief valves, cast iron construction, as manufactured by United Blower, or approved equal. Pressure relief valve shall be rated and sized to relieve 110% of the maximum calculated airflow at the specified local conditions.

M. Ten inch diameter discharge check valves shall be provided on the discharge of each blower unit, outside of the acoustical enclosure and shall be Tozen Style CV-SST. Check valve shall be ductile iron with 316 SST shaft and plate, Inconel springs, and EPDM sealing member suitable for 300$^{o}$F.

N. Ten inch diameter butterfly valves shall be provided on the discharge of each blower unit, outside of the acoustical enclosure and shall be Tozen wafer style butterfly valves. Butterfly valve shall be cast iron with 410 SST shaft, aluminum bronze disc, and EPDM seat.

O. Provide molded, synthetic rubber and cork, vibration isolation pads for each blower, sized to fit the structural steel base. Isolators shall be as manufactured by Korfund or equal.

P. Provide a differential pressure gauge to indicate pressure drop through the air filter for each blower. Gauge shall be Model 2015 by Dwyer Instruments, Inc. or approved equal.

1. Range: 0 to 15 inches water gauge.

2. Accuracy: 2% of full scale.

3. Dial: 4-1/2"; 120° scale; 0.5 WC minor divisions.

4. Mounting: Vertical

5. Construction: Die cast aluminum case; silicone rubber diaphragm; calibrated range spring; samarium-cobalt magnet; heli of high magnetic permeability mounted in sapphire bearings; clear plastic cover with O-ring seal and zeroing screw; litho-printed scale; red-tipped pointer with rubber pointer stops.

6. Vacuum gauge shall be located outside of the acoustical enclosure.

Q. Provide a liquid filled pressure gauge for each blower. Gauge shall be Type 1008A manufactured by Ashcroft or approved equal.

1. Range: 0 to 15 psig.

2. Accuracy: 1% of full scale.

3. Dial: 4-inch diameter; 270° scale; heavy gauge aluminum with white background and black markings; 0.25 psig minor divisions.

4. Case: Stainless steel.

5. Ring: Stainless steel.

6. Movement: Stainless Steel

7. Bourdon Tube: Phosphor bronze, large bore tubing which is silver soldered to socket and tip.

8. Connection: Forged brass 1/4" NPT black connection.

9. Pressure gauge shall be located outside of the acoustical enclosure on the discharge piping.

R. Provide a liquid filled bimetal thermometer for each blower manufactured by Ashcroft or approved equal.

1. Range: 50 to 300°F Series EL discharge and - 40 to 160°F inlet.

2. Accuracy: 1% full span.

3. Dial: 3" diameter; 270° scale; heavy gauge stainless steel with white background and black markings; 5°F minor divisions.

4. Case: Stainless steel.

5. Ring: Stainless steel.

6. Movement: Stainless steel.

7. Actuating Element: Type 304 stainless steel, precision rolled, fully annealed tubing.

8. Compensation: Bimetal compensator to offset ambient temperature changes in case area.

9. Thermometer shall be located outside of the acoustical enclosure on the discharge piping.

S. A high temperature switch for each blower shall be provided as manufactured by Ashcroft, Type 400, T4 Series, or approved equal with an operating range of 150° to 325°F. The maximum temperature capability shall be 400°F. Sensor is to be capillary type with remote 3-3/4" brass bulb. Contractor shall provide 1/2" FPT in discharge piping near blower for thermostat well. Piping under 4 inches will require a tee with bushings to mount the well. Piping 4 inches and over may be drilled and tapped. Temperature switch shall be installed by the blower manufacturer on the outside of the acoustical enclosure on the discharge piping installed by others.

T. A high pressure switch for each blower shall be provided as manufactured by Ashcroft, Type 400, B4 Series, or approved equal. Pressure switch operating range shall be from 1 to 20 psig. Actuator seal shall be Viton. Pressure switches shall have adjustable deadband, hermetically sealed switching element, and 316 stainless steel pressure port. Pressure switch shall be installed by the blower manufacturer on the outside of the acoustical enclosure on the discharge piping installed by others.

U. Control of the positive displacement blower packages shall be as described in Section 17950 – Functional Control Descriptions.

2.02 ACOUSTICAL ENCLOSURE

A. An individual acoustical close-fitting enclosure shall be provided for the blower package as specified herein and as shown on the Drawings. The acoustical enclosure shall be compatible with the positive displacement blower system furnished in this specification section and shall comprise a complete system. The acoustical enclosure shall reduce blower noise level to a maximum of 79 dbA within 3 feet of the enclosure.

B. The enclosure shall be constructed to easily accommodate service and maintenance functions. The enclosure shall have removable front and side panels.

C. The enclosure shall include a removable 1-piece roof panel with 4 lifting eyes, which shall permit removal of blower and/or the motor without removal of the enclosure. The roof top shall be secured to the enclosure aluminum tubular frame with rotating latches (2 per side).

D. Cooling air shall be drawn from outdoor air and shall be vented through louvers at the top of the vertical panels. Louvers shall be sized in conjunction with air draw. Blower supplier shall be responsible for ventilation system and shall provide details of design during Shop Drawing Submittal. Temperature shall be maintained to within 15$^{o}$F of filter building ambient temperature in the enclosure by the ventilation system.

E. Each close fitting enclosure shall be provided with four vertical panels secured to an aluminum tubular frame with quick connecting latches. The sub frame shall provide for

forklift pickup complete with two channels for the blower package support. Enclosure and blower package shall be shipped as an integral unit. In addition the (4) corner plates shall be welded to the sub base frame to provide anchor bolt holes. The roof frame shall be removable to remove blowers and motors vertically upwards.

F. Sound Absorption Panel Construction

1. Sound absorbing panels shall be minimum 2" thick and furnished in lengths, widths, and height as required. Panels shall consist of a 14 gauge galvanized steel perimeter channel frame and front face. All galvanizing shall be in accordance with Section 05035 – Galvanizing. Panel shall be adequately reinforced inside with stiffeners, to prevent twisting and racking during shipment and installation.

2. Each panel shall contain minimum 2" thick sound absorbing polyurethane foam, 4 lbs. PCF, applied in the factory.

3. Galvanized panels shall be welded construction and shall contain sound absorbing and insulating fill material with ratings not less than the following when tested in accordance with ASTM E84050T, NFPA Standard 255 or UL 723.

| | | |
|---|---|---|
| Flame Spread | - | 15 |
| Smoke Developed | - | 0 |
| Fuel Contribution | - | 0 |

G. Acoustical sound traps (foam lined) shall be furnished and installed, as required, to achieve the specified sound level. Sound trap construction shall conform to the following:

1. Outer casing shall be of 16 gauge galvanized steel, foam liner to be 2 inch.

H. All enclosure fasteners and anchor bolts shall be Type 316 stainless steel.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION AND TESTING

A. The equipment shall be installed in accordance with the instructions and drawings of the manufacturer and Section 11000 - Equipment General Provisions.

B. All supports, fasteners, anchors, equipment, hardware, and other devices shall be furnished for a complete installation.

C. Prior to field testing of blower equipment, the Contractor shall take all necessary precautions to insure that the piping is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with acceptable operation.

D. After each blower unit and its accessories have been completely installed and the electrical connections have been made, it shall be subjected to field tests conducted by the Contractor and witnessed by the Engineer to determine if it is free from all

objectionable vibration, bearing heating, noise or other defects. Vibration shall not exceed 3 mils at any bearing in any plane. Noise level shall be measured along each side of the enclosure to verify conformance to the maximum noise level specified. Each blower unit shall be subjected to running tests under actual operating conditions for a period of 4 hours during the field test. The Contractor shall make such changes or alterations to the blower units or their auxiliaries necessary for satisfactory operation as directed by the Engineer based on the results of the field tests.

3.02 PAINTING

A. Painting shall be as specified in Section 09900 unless otherwise specified herein. Blowers shall be coated with the manufacturer's recommended premium paint system suitable for the blowers' intended use.

B. All inaccessible surfaces of the equipment, which normally require painting, shall be finished painted by the manufacturer. The equipment and motor shall be painted with a high quality epoxy polyamide semi-gloss coating specifically resistant to chemical, solvent, moisture, and acid environmental conditions, unless otherwise specified.

C. Gears, bearing surfaces, and other unpainted surfaces shall be protected prior to shipment by a heavy covering of rust-preventive compound sprayed or hand applied which shall be maintained until the equipment is placed in operation. This coating shall be easily removable by a solvent.

3.03 SPARE PARTS

A. Furnish all special tools and appliances necessary to disassemble, service, repair and adjust the equipment and appurtenances.

B. All materials shall be properly packed, labeled and stored where directed by the manufacturer or Engineer.

C. Spare parts which are identical and interchangeable with the original parts shall be furnished in clearly identifiable and labeled containers. The Contractor shall provide the following spare parts:

- Two (2) filter elements
- One (1) year supply of manufacturers recommended oil
- Complete set of seals, gaskets, and V-belts.
- Spare sheaves as required to reduce air flow to 1000 scfm

3.04 EQUIPMENT IDENTIFICATION

A. The blowers shall be provided with a substantial brass or stainless steel nameplate, securely fastened in a conspicuous place, and clearly inscribed with the manufacturer's name, year of manufacture, serial number, design air flow, pressure and rpm.

- END OF SECTION -

SECTION 11501

CHEMICAL INJECTION AND DIFFUSER ASSEMBLIES AND SAMPLING PROBES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide chemical injector and diffuser assemblies and sampling probes as shown on the Drawings and/or as specified herein.

B. Each injector and diffuser assembly shall be specifically designed for the particular chemical service for which it is being supplied. The materials of construction for the injector and diffuser assemblies shall be compatible with the chemicals being fed.

C. Equipment shall be provided in accordance with Section 11000, Equipment General Provision, and Division 15.

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Injectors and Diffusers

| Service | Sodium Hypochlorite | Sodium Hypochlorite | Sodium Hypochlorite |
|---|---|---|---|
| Application Point | Filter Influent Channel | Filtered Water Control Vault | Chemical Vault |
| No. of Assemblies | 1 | 1 | 1 |
| Type of Feed Device | Diffuser | Diffuser | Injector |
| Maximum Concentration (%) | 5% | 5% | 5% |
| Solution Pipe Diameter (in) | 1 | 1 | 1 |
| Solution Pipe Material | Sch. 80 PVC | Sch. 80 PVC | Sch. 80 PVC |
| Maximum Feed Rate of Solution (gph) | Same as Existing | Same as Existing | Same as Existing |
| Metering Pump Maximum Discharge Pressure (psi) | 100 | 100 | 100 |
| Receiving Pipe Diameter (in) | - | - | 36 |
| Diffuser Length (in) | 12 | 12 | N/A |
| Receiving Pipe Material | - | - | Ductile Iron |
| Location of Feed Point | Over Influent Pipe | Weir of Control Vault | FLW Pipe |
| Maximum Receiving Pipe/Basin Pressure (psi) | - | - | 10 |
| Maximum Receiving Pipe/Basin Velocity (fps) | 5 | 5 | 5 |
| Location of Feed Point into Receiving Pipe | See Drawings | See Drawings | See Drawings |

| Service | Fluoride | Ammonia | Zinc Orthophosphate |
|---|---|---|---|
| Application Point | Chemical Vault | Chemical Vault | Chemical Vault |
| No. of Assemblies | 1 | 1 | 1 |
| Type of Feed Device | Injector | Injector | Injector |
| Maximum Concentration (%) | 25% | 5% | 5% |
| Solution Pipe Diameter (in) | 1 | 1 | 1 |
| Solution Pipe Material | Sch. 80 PVC | Sch. 80 PVC | Sch. 80 PVC |
| Maximum Feed Rate of Solution (gph) | Same as Existing | Same as Existing | Same as Existing |
| Metering Pump Maximum Discharge Pressure (psi) | 100 | 100 | 100 |
| Receiving Pipe Diameter (in) | 36 | 36 | 36 |
| Diffuser Length (in) | N/A | N/A | N/A |
| Receiving Pipe Material | Ductile Iron | Ductile Iron | Ductile Iron |
| Location of Feed Point | FLW Pipe | FLW Pipe | FLW Pipe |
| Maximum Receiving Pipe/Basin Pressure (psi) | 10 | 10 | 10 |
| Maximum Receiving Pipe/Basin Velocity (fps) | 5 | 5 | 5 |
| Location of Feed Point into Receiving Pipe | See Drawings | See Drawings | See Drawings |

B. Sampling Probes

| Location | Filter Effluent |
|---|---|
| No. of Assemblies | 8 |
| Type of Feed Device | Sample Probe |
| Sample Pipe Diameter (in) | 1 |
| Sample Pipe Material | Sch. 80 PVC |
| Receiving Pipe Diameter (in) | 18 |
| Receiving Pipe Material | Ductile Iron |
| Location of Sample Point | Filter Gallery |
| Maximum Receiving Pipe Pressure (psi) | 15 |
| Maximum Receiving Pipe Velocity (fps) | 5 |
| Location of Sample Point into Receiving Pipe | See Drawings |

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to, the submittal requirements specified in Section 01300, Submittals,

and Section 11100, General Process Mechanical Requirements:

1. Equipment specifications and data sheets, with identification of all materials of construction.

2. Complete assembly, layout, installation and shop drawings, with clearly marked dimensions, tolerances, jointing and anchoring details.

3. Equipment cross-section drawings.

4. Weights of equipment component parts.

5. Chemical resistance data for wetted parts

## PART 2 -- PRODUCTS

### 2.01 GENERAL

A. The chemical injection and diffuser assemblies and sampling probes shall be Saf-T-Flo as manufactured by Martin Special Products Company, Inc., 4071E. La Palma Avenue, Suite L, Anaheim, CA 92807.

### 2.02 CONSTRUCTION AND MATERIALS

A. Each injector/diffuser assembly shall be specifically designed for the particular chemical service for which it is being supplied. The materials of construction for the assemblies shall be compatible with the chemicals being fed and shall be suitable for the pressure in the chemical solution line and receiving pipe, and the maximum velocity in the receiving pipe.

B. The injector/diffuser assemblies shall be furnished with a corporation stop, self-sealing coupling, solution tube assembly including ball check valve, self-sealing poppet valve, elastomeric check valve to prevent clogging of the tip of the solution tube, locking device, and safety chain. The locking device shall connect the solution tube to the corporation stop on the receiving pipe to prevent accidental withdrawal of the solution tube. The stainless steel safety chain shall prevent the solution tube from being withdrawn past the corporation stop. Safety chain length shall be determined by the manufacturer of the equipment.

C. The assemblies shall be sized to match the pump discharge line or injection flow rate and shall be of the same diameter as the solution piping. The injector assembly solution tubes shall penetrate into the pipe a distance equivalent to 1/3 to 1/2 of the pipe diameter into which the chemicals are being injected. The diffuser assembly shall be provided with orifices in the number and size indicated on the Drawings. The holes shall be equally spaced along the length of the diffuser tube.

D. Each sampling probe shall be retractable and shall be designed for the particular location for which it is being supplied. Each probe shall be furnished with a corporation stop, self-sealing coupling, sample tube assembly with isolation valve, locking device, and safety chain. The sampling probes shall penetrate into the pipe a distance equivalent to 1/3 to 1/2 of the pipe diameter into which the probe is inserted.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish the chemical injectors and diffusers and sampling probes and all associated equipment and accessories as required and specified herein in accordance with the manufacturer's instructions and in accordance with Section 11000, Equipment General Provision.

B. Mounting racks shall be provided for chemical feed piping, valves, and appurtenances as shown on the Drawings and/or as specified herein. The racks shall be constructed of fiberglass channel members, and shall allow valves and appurtenances to be mounted such that they are readily accessible by plant operations personnel for operation and maintenance. The mounting racks shall be as specified in Section 15020, Pipe Supports.

- END OF SECTION -

SECTION 13221

FILTER MEDIA

PART 1 -- GENERAL

1.01 WORK INCLUDED

The Contractor shall provide all labor, material and equipment required to furnish, install, test, and place into satisfactory operation sand and granular activated carbon (GAC) filter media in the specified filter boxes, as shown on the Contract Drawings and as specified herein.

1.02 RELATED SPECIFICATIONS

A. Division 1 - General Requirements

1.03 REFERENCES

A. American Water Works Association (AWWA)

1. AWWA Standard B100-01 – Granular Filter Material.

2. AWWA Standard C653 – Disinfection of Water Treatment Plants.

B. National Sanitation Foundation (NSF)

1. NSF 61 – Drinking Water System Components - Health Effects.

C. American Society for Testing and Materials (ASTM)

1. ASTM E11 – Specifications For Wire Cloth and Sieves For Testing Purposes.

2. D4607 - Standard Test Method for Determination of Iodine Number of Activated Carbon

3. D2867 - Standard Test Methods for Moisture in Activated Carbon

4. D2862 - Standard Test Method for Particle Size Distribution of Granular Activated Carbon

1.04 SYSTEM DESCRIPTION

Filter dimensions are as follows:

| No. of Filters | Cell length | Cell Width |
|---|---|---|
| 8 | 24’-10” | 20’-0” |

1.05 DESIGN REQUIREMENTS

A. Filter media shall conform to the following specifications:

| Layers | Material | Depth after installation (inches) | Specific Gravity/ Apparent Density | Effective Size (mm) | Uniformity Coefficient |
|---|---|---|---|---|---|
| One (1) | Sand | 12.0 | 2.60 to 2.70 | 0.45 to 0.55 | <1.4 |
| One (1) | GAC | 24.0 | 0.48 – 0.60 g/cc | 1.0 to 1.1 | <1.5 |

B. The depth of sand is shown after installation and scraping as per latest version of AWWA Standard B100 to remove fines. Excess media shall be installed to allow for scraping and for voidage changes.

C. All products must conform to the requirements of the Safe Drinking Act and American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61

1.06 SUBMITTALS

A. The contractor shall obtain from the media manufacturer and submit the following:

1. Manufacturer's name, manufacturing location and address and product name or number,

2. Working Drawings.

3. Lists of Spare Parts, Special Tools and Supplies.

4. Reports of Certified Shop Tests.

5. Reports of Field Tests.

6. Reports of Manufacturer's Representative Site Visits.

7. Samples

8. Affidavit of compliance for the media stating that the media furnished complies with the applicable provisions of the latest revisions of AWWA B100.

B. Working drawings shall include, but not be limited to, the following:

1. Filter media specifications, MSDS and data sheets, with identification of all materials used and methods of fabrication.

2. Complete installation drawings with clearly marked dimensions, volumes and lot numbers.

3. Manufacturer's delivery, storage, and handling requirements.

4. Manufacturer's installation instructions and recommendations.

5. Expansion curves for the filter media, showing backwash rate versus percent bed expansion for temperatures between 33ºF and 80ºF.

6. Certified GAC test reports for gradation, material source, reagglomeration/thermal process and samples of the filter media that will be used as part of this project tested as specified in AWWA B604.

7. Certification that the sand and GAC satisfy the requirements in Articles 1.05 and 2.04 of this specification. Certificates of conformance shall accompany the filter media deliveries to the site.

8. A detailed description of the procedures for filter media placement.

9. Evidence of manufacturer experience and of the successful operation in other facilities of media similar to that proposed for this project, as specified herein and in the General Conditions.

10. Affidavit of Compliance as defined in NSF Standard No. 61.

C. Spare parts lists shall indicate sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" shall not be acceptable.

D. Reports of certified shop tests shall be submitted as specified herein. No filter media shall be shipped from its place of manufacture before the certified shop test reports have been approved by the Engineer. Prior notification of shop tests shall be submitted and shall include, but not be limited to, a description of the proposed testing facilities and procedures.

E. Documentation regarding delivery trailer unloading procedures, information on trailer materials used that come in contact with the GAC, that these materials are U.S. Food and Drug Administration approved, and that the trailers are dedicated to the transport of potable grade GAC or filter media.

F. Reports of field tests shall be submitted as specified herein.

G. Reports of manufacturer's representative Site visits shall be submitted as specified herein.

H. Samples shall be submitted as specified herein.

I. Other applicable submittals, as required elsewhere in the Contract Documents. If requested, Valid ISO 9001 certification shall be provided for the plant of manufacture for the GAC.

1.07 QUALITY ASSURANCE AND QUALIFICATIONS

A. Manufacturer/Supplier's Qualifications.

1. The Contractor shall provide evidence to the Engineer that the manufacturer/supplier has a minimum of five (5) years of experience, within the last seven (7) years, in the design, manufacture, and supervision of installation of filter media of the type required under this Specification.

2. The Contractor shall provide evidence to the Engineer that filter media which was designed and manufactured by the manufacturer, and which is similar to the filter media required under this Specification, has been in continuous and successful operation in at least five (5) separate facilities for the past five (5) years.

B. All filter media provided under this Specification shall be the product of a single manufacturer/supplier.

C. The filter media manufacturer/supplier shall supervise the transportation, handling, on-site storage, and placement of the filter media. The filter media manufacturer/supplier shall also supervise the field preparation of the media for sampling, including backwashing the media prior to sampling.

D. All filter media testing shall be performed by a laboratory that has demonstrated at least 3 years of performing analyses in accordance with the latest version of AWWA Standard B100

E. An Affidavit of Compliance shall be furnished certifying that the media is shipped in containers free from harmful contaminants as defined in NSF Standard No. 61.

F. Each package and container shall have legibly marked on it the name of the material, the gradation, filling date, the net weight of the contents, the name of the manufacturer/supplier, the lot number, and the brand name (if any). These markings shall be ineffaceably stenciled on the bag.

G. Bag or semi-bulk container shipment of media will be accepted. Bag or semi-bulk containers shall be UV resistant. Semi-bulk containers shall not exceed 4,000 lbs in weight. Semi-bulk containers shall include a crane loop and rope locks for lifting by a crane. Bulk media shipment will not be allowed. Placement in the filters shall be accomplished using hydraulic slurry transfer or directly from bags or semi-bulk containers.

H. The Contractor shall provide the services of an independent testing laboratory to perform the field tests specified herein below. The laboratory shall be experienced in the type of testing to be performed, and the suitability of the laboratory to provide these services shall be subject to the approval of the Engineer.

1.08 SPARE PARTS, SPECIAL TOOLS, AND SUPPLIES

A. The Contractor shall provide spare filter media, as specified herein and in Division 1 – General Requirements.

B. The Contractor shall provide such special tools and appliances as may be needed to test, place or replace the filter media (such as rakes or screens) furnished under this Specification.

1.09 SHOP TESTS

A. Certified shop tests shall be performed for all filter media provided under this Specification.

B. Shop tests shall confirm, via samples taken from the point of distribution that the filter media proposed for supply under this Specification conforms to the design requirements in Article 1.05, and to the product specification requirements in Article 2.03 and Article 2.04 herein.

C. Upon delivery to the site; affidavit signed by a high ranking officer of the manufacturer shall be provided by the driver stating that the supplied media is the same media tested in the approved shop test results.

PART 2-- PRODUCTS

2.01 MANUFACTURERS/SUPPLIERS

A. Sand filter and support media shall be as purchased by F.B. Leopold Company; Unifilt Corporation; Roberts Filter Company, or equal. Only suppliers who regularly furnish sand filtration media for the municipal water treatment industry will be considered for approval. All sand and support media supplied under this contract shall be manufactured by the same company, GAC from multiple manufacturers will not be acceptable.

B. GAC shall be Cabot Norit 820 or Calgon Carbon Filtrasorb 820-M. Only suppliers who regularly furnish GAC filtration media for the municipal water treatment industry will be considered for approval. All GAC supplied under this contract shall be manufactured by the same company, GAC from multiple manufacturers will not be acceptable.

2.02 GENERAL

A. Filters shall be provided with support media, sand, and GAC media as specified and as shown on the Drawings.

2.03 SUPPORT MEDIA

A. Support gravel shall conform to the following profile:

| Depth of Layer | Effective Size |
|---|---|
| 3” | 1/8” x 10 mesh |
| 3” | ¼” x 1/8” |
| 3” | ½” x ¼” |
| 3” | ¾” x ½” |

2.04 GRANULAR ACTIVATED CARBON (GAC)

A. GAC Product Specifications

| | | |
|---|---|---|
| 1. | Iodine Number | 900 mg/g (min) |
| 2. | Apparent Density | 0.48 – 0.60 g/cc |
| 3. | Moisture, wt % | 2 % (Max) |
| 4. | Effective Size | 1.0 – 1.1 mm |
| 5. | Uniformity Coefficient | < 1.5 |
| 6. | Abrasion No. (ROTAP) | 75 (min) |
| 7. | Water Soluble Ash | 4% (max) |
| 8. | Mesh Size, US Sieve Series | 8 x 20 |
| 9. | Screen Size (US Sieve), wt% | |
| | Larger than No. 8 | 5 (max) |
| | Smaller than No. 20 | 4 (max) |

B. GAC Product Qualifications

1. The GAC shall be virgin quality.

2. The GAC shall be manufactured in the United States of America.

3. GAC shall be a re-agglomerated bituminous coal based product with petroleum or coal based pitch binders sized to a granular form prior to baking and activation. Lignite based GAC or broken pellets will not be accepted. Direct activated GAC will not be accepted.

4. GAC shall be activated by steam under rigidly controlled conditions.

5. The GAC must possess superior hardness and abrasion characteristics to withstand repeated backwashes, transfers and handling without significant change in physical size or loss of GAC volume.

6. The GAC shall be capable of removing color, tastes, odors, disinfection by-products, disinfection by-product precursors and other organic contamination from water previously pretreated by conventional water treatment processes.

7. The GAC shall contain no soluble inorganic or organic substances in quantities capable of producing deleterious or injurious effects upon the health of those consuming the water or that would otherwise render the water treated by the GAC unfit for public use. The GAC shall not impart to the water any contaminant that exceeds the maximum limits as defined by the Safe Drinking Water Act Public Law 93-523 or any of its amendments, or NSF 61 standards.

2.05 SAND

A. Filter sand media shall conform to the requirements specified above in Paragraph 1.05. The filter sand shall be high grade silica sand complying with the Standard Specifications for Granular Filter Material (AWWA B100-01). It shall be well graded. Material showing abnormal grading shall be rejected. The sand shall be washed silica and completely free

from mica, dust, dirt, and foreign substances of any kind. Sand shall have an acid solubility less than 5 percent.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. Installation of materials provided under this Specification shall be in accordance with the manufacturer/supplier's recommendations and the approved working drawings. Filter boxes shall be leak tested and disinfected prior to media placement. Beginning media installation means the installer accepts that the surfaces and underdrains are acceptable for installation.

B. Additional instructions for the installation of materials provided under this Specification are as follows:

1. Installation and the preparation of the filter for service shall be in accordance with the AWWA B100-01 unless specifically noted otherwise herein.

2. Following filter underdrain installation, the filter box shall be thoroughly cleaned by brooming and vacuuming before any media is placed and shall be kept clean throughout the operation.

3. The Contractor shall take measures to control dust during installation. If the filter media is bagged or in semi-bulk containers, the media shall be wetted to control dust as it is placed. The underdrain in each filter cell shall be inspected by the Contractor for any defects and/or damages, prior to installation of the new filter media.

4. Media shall be placed in the filters hydraulically as a slurry or manually from bags or semi-bulk containers. GAC shall be added hydraulically through an educator, slurry pump, blow case, or directly from specially built bulk trucks into a filter box partially filled with water. Under no circumstance shall media be discharged into the box from the operating level.

5. The Contractor shall exercise caution in installing media to avoid damage to the filter underdrain system. Any damage to underdrains or other plant facilities resulting from work by the Contractor shall be repaired at the Contractor's expense. Each layer shall be completed before the layer above is started. The bottom layer shall be placed carefully by hand to avoid damage to the underdrain system and to ensure a free passage of water from the orifices. Workmen shall not stand or walk directly upon the media, but upon boards or staging so that the weight of the workmen will not displace the media as indicated in AWWA B100. All equipment used in placing GAC shall be cleaned and disinfected in accordance with AWWA C653. All workers shall use boots and gloves

6. The Contractor shall not support any staging equipment or personnel from the filter washwater troughs at any time.

7. Filter sand shall be installed in a uniform thickness with the top surface brought to a true level plane. Bulk media may be placed dry or wet as specified in AWWA B100-01. When shipped in bags, filter media may be placed by scattering material directly from the bags. The elevation of the top surface of each filter media layer shall be checked by filling the filter with water to the level line previously marked on the inside of the filter.

8. After the sand has been placed, the media shall be washed and scraped or skimmed to remove excess fine material. Wash water shall be slowly admitted upward through the underdrain system until the entire bed is flooded. The flooded bed shall be allowed to stand for as long a period as deemed necessary before initial wash and shall not be less than 12 hours. If the media is placed via a slurry method, the standing period will be waived. The wash rate shall be increased gradually during the initial wash to remove air from the bed. During each backwash, the water shall be applied at an initial rate of not more than 2 gpm/$ft^2$ of filter area. The backwash rate shall then be increased gradually over a period of 1.5 minutes. The filter bed shall be backwashed for a total period of not less than 30 minutes in order to stratify the bed and to wash out dirt. This process will require several separate backwashes, but not less than 3 backwashes at 10 minutes each at an expansion of not less than 30 percent followed by a slow closing of the wash water valve. Following each backwash, the top layer of sand shall be removed such that after the last backwash a total of 1/2-inch of sand media shall have been removed and discarded, and the final surface leveled. The depth of media, as specified herein, shall be measured in place after backwashing.

9. The field tests specified in Article 3.02 below shall then be conducted.

10. After the sand has been placed, leveled, washed, scraped, and tested, the GAC shall be placed and leveled as described in Sections 3.01 B.7. through 3.01.B.9., above.

11. The filters shall be maintained completely clean and free of any debris or other foreign materials at all times. Filters shall be cleaned to the satisfaction of the Owner's Representative prior to chemical coating and disinfection.

12. The Contractor shall remove from the job site and dispose of all excess or rejected filter media and the area around the filters shall be cleaned at the end of each working day.

13. All tanks, channels, etc., used in the course of the placement of the media into the filters shall be completely cleaned.

3.02 FIELD TESTING

A. The Contractor shall collect all media samples and shall engage the services of an independent laboratory that will process the samples collected in accordance with ASTM standards and as described herein.

B. A minimum of one composite sample of the sand and one composite sample of the GAC shall be taken for sieve analysis from the first filter cell. Each composite sample shall

consist of equal portions from a minimum of five cores. Four cores shall be taken at the corners approximately 2 feet from the walls, and one core shall be taken near the center-line of the filter surface and under a trough. These cores shall be taken using a sample thief as described in AWWA B-100 or a Wilson core sampler. The core sampler shall be inserted to the elevation required to capture the full profile of the media being sampled and then removed by excavating around it in order to extract a complete profile of the material found above that elevation. If the sand or GAC fails the field tests as specified herein, the Contractor shall take all necessary measures to correct any deficiencies revealed by these tests and shall repeat the tests until such deficiencies are corrected. Tests shall be repeated in subsequent filter cells until conformance with these specifications is achieved. Additional requirements for the field testing of the materials provided under this Specification are as follows:

1. Upon completion of the backwashing procedure specified in Article 3.01 above for sand, a sieve analysis shall be made of composite samples of the sand to determine the gradation, uniformity coefficient and effective size of the collected samples described above. Further backwashing and scraping shall be carried out until the requirements specified herein are satisfied. After completion of field testing for sand filter media, placement of GAC filter media may commence.

2. Upon completion of the backwashing procedure specified in Article 3.01 above for GAC, a sieve analysis shall be made of composite samples of the GAC to determine the gradation, uniformity coefficient and effective size of the collected samples described above. An acid solubility test shall also be conducted.

3. After filter materials have been placed, soaked and initially backwashed, each filter shall be backwashed three times, for at least ten minutes each time. After each backwashing the filter media shall be allowed to compact by slowly reducing the washwater flow.

3.03 DISINFECTION

A. After all work within filter box has been completed, and after the media is installed, tested, and chemically conditioned, disinfect the entire filter box by chlorination per Section 13450.

3.04 MANUFACTURER/SUPPLIER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer/supplier's representative to: assist in the installation of the filter media; check the installation before the media is placed into operation and assist in the performance of field tests. The services provided shall be in accordance with the requirements of the General Conditions.

B. The Contractor shall provide the services of the manufacturer/supplier's representative at such times and for such durations of time as needed to perform the tasks required of the representative. At a minimum, the services of the manufacturer/supplier's representative shall be provided as indicated herein below. The number of visits and person-days per visit indicated below shall be understood as referring to the total required services for the lot of filter media provided under this Specification.

1. Installation and field testing: 3 visits of 1 day per visit and shall be as follows (and as described below) for media installation in the first filter cell:

    a. 1 day to witness the unloading of the media.
    b. 1 day to witness the media installation.
    c. 1 day to witness the media testing.

C. The Contractor shall provide the services of person(s) authorized by the manufacturer/supplier to witness the unloading at the Site of the filter media provided under this Specification, and to ascertain the condition of said media. Manufacturer/supplier's sales and marketing personnel may be accepted as authorized person(s) to perform these specific tasks. The Contractor shall submit to the Owner's Representative a report, completed by the authorized person(s) and certified by the filter media manufacturer, documenting the findings of the authorized person(s).

D. Media installation and testing shall be witnessed by a direct employee of the filter media manufacturer/supplier, with at least three (3) years of experience in the installation, testing and start-up of filter media of the type provided under this Specification unless otherwise authorized by the Owner. The manufacturer/supplier's sales and marketing personnel will not be accepted as manufacturer/supplier's representatives.

E. The manufacturer/supplier's representative shall meet with the Underdrain and equipment installers and shall have full knowledge and experience in the installation of the filter media in filter systems of the type to be provided under this Contract.

F. Reports: The Contractor shall submit a report from the manufacturer/supplier for each visit to the Site of the manufacturer/supplier's representative. The report shall provide complete information regarding the visit, including, but not limited to, dates, times, subject media, tasks performed, persons contacted, problems corrected, test results, training provided, and other pertinent information.

G. Qualified engineers of the manufacturer/supplier shall inspect the filters before placement of the filter media.

- END OF SECTION -

SECTION 13225

FIBERGLASS BACKWASH TROUGHS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Provide all labor, material, and equipment required to furnish, install and place into satisfactory operation, fiberglass backwash troughs in eight filters complete and as shown on the drawings and as specified herein. The Contractor shall be responsible for the coordination with related work specified elsewhere and to provide all hardware, accessories and appurtenances required for a complete installation, including all fabrication and mounting hardware. All metal components and accessories located in the filters shall be 316 (or 316L) stainless steel. Carbon steel, brass, bronze and aluminum inside the contactor basin shall not be acceptable.

B. Backwash troughs shall be designed to structurally withstand all loads imposed during the backwashing operation with substantially no deflections. The troughs shall be sized such that there is a minimum of two (2) inches freeboard at the blind end with free discharge conditions at the gullet end at a backwash rate of 20 gpm/sf of the total contactor area of 496 sf. There shall be four (4) troughs per filter; each trough will be sized for 2500 gpm.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01300, Submittals

B. Section 05050, Metal Fastening

B. Section 06610, Glass Fiber and Resin Applications

C. Section 07900, Joint Fillers, Sealants, and Caulking

D. Section 09900, Painting

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. ASTM D3917 - Standard Specification for Dimensional Tolerances of Thermosetting Glass - Reinforced Plastic Pultruded Shapes

2. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products

3. AWWA – American Water Works Association.

a) C653 – Disinfection of water treatment plants.
b) F101 – Contact, molded, fiberglass, reinforced plastic (FRP) washwater troughs and launders.
c) F102 – Matched, die-molded, fiberglass, reinforced plastic weir plates, scum baffles and mounting brackets.

4. NSF – Standard 60 and 61 – Drinking Water Systems Components – Health Effects.



1.04 SUBMITTALS

A. Submit shop drawings showing fabrication details and a Performance Affidavit for all items specified herein in accordance with Section 01300, Submittals and Section 11000, Equipment General Provisions and shall include the following:
1. Manufacturer's name and model numbers.
2. Manufacturer's standard product data.
3. Bill of material.
4. Weights of equipment component parts, assembled weight of equipment and total shipping weight.
5. Certification of warranty
6. Dimensional layouts and required clearances.
7. Anchor bolts.
8. Complete description of sufficient detail to permit an item by item comparison with the specifications.
9. Overall plans sections, structural calculations and materials of construction for troughs.
10. Installation instructions including recommendations and leveling requirements.
11. Affidavit of compliance stating the equipment and any resins and elastomers are ANSI/NSF 61 certified as non-tainting and non-toxic.
12. Design calculations or shop test results indicating compliance with the structural design and deflection requirements of this specification signed by a Professional Engineer. Provide all dynamic loads and weight when full.
13. Graphs and calculations in support of trough capacity, stress and deflections incurred during normal operating conditions.

B. Certification of compliance with ASTM Standards.

C. Design calculations shall be sealed by a currently Registered Professional Engineer.

1.05 QUALITY ASSURANCE

A. All fiberglass items to come in incidental contact with drinking water shall demonstrate conformance to the applicable American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 60 or 61; or Underwriter Laboratory (UL) standards.

B. All fiberglass items of the same type provided shall be the products of a single manufacturer for compatibility.

C. It shall be the Contractor’s responsibility to ensure the fiberglass items and appurtenances furnished shall be compatible and have the necessary operating clearances with the structural elements and equipment shown on the Drawings.

D. Manufacturer shall provide a 3 year warranty on all FRP products against defect in material and workmanship.

## PART 2 -- MATERIALS

### 2.01 GENERAL

A. The manufacturer shall maintain a continuous quality control program and shall, upon request, furnish the Engineer with certified test reports consisting of physical tests of samples.

B. The resin shall be ANSI/NSF 61 certified, commercial grade, general purpose polyester thermosetting resin with no fillers other than those added for viscosity control and pigments, dyes or colorants which will not fade or chalk from the original color. All laminates shall have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.

C. All FRP resins shall be flame resistant and shall meet the requirements of ASTM D 635 and ASTM E 84, Class 1 with a maximum flame spread rating of 25.

D. All edges shall be sealed in the mold where possible. Machined or cut edges shall be sealed with a compatible resin system.

### 2.02 FILTER BACKWASH TROUGHS

A. Effluent troughs shall be furnished and installed as shown on the Drawings. Troughs shall be manufactured by Fiberglass Fabricators, Inc., NEFCO Inc.; Warminster; Roberts Water Technologies, Inc.; or F.B. Leopold Co. or equal.

B. Effluent troughs shall be constructed of fiberglass reinforced polyester (FRP), and shall be the length and size as indicated on the Drawings. The troughs shall be round bottom, integral weir design with sharp crested discharge, one end open and one end closed. The troughs shall be designed with longitudinal stiffeners and cross braces to minimize deflection with trough full or empty and contactor full or empty. All fasteners, braces and anchors shall be Type 316 stainless steel and be provided by the trough manufacturer. Each trough shall have a minimum wall thickness of 1/4-inch, and shall be reinforced with triangular shaped longitudinal stiffener sections molded as an integral part of the trough.

C. The troughs shall be designed to support gravity, buoyant and lateral loads imparted on the troughs by their own weight, accessories, and the forces of the water in contact with trough. Deflection calculations shall consider the case when the trough is empty and the contactor is full and when the trough is full and the contactor is empty.

1. Capacity shall be 2500 gallons per minute with a minimum of two (2) inches freeboard at the blind end with free discharge conditions at the gullet end at a backwash rate of 20 gpm/sf over 496 square feet of filter surface area. There will be four (4) troughs per contactor.

2. Trough weir edge shall provide a sharp crested discharge. If stiffeners are required, the stiffeners shall be located at a sufficient depth so as not to impede aeration underneath the nappe.

3. Torsional Stability. The trough system shall resist torsional oscillations induced by the flow of water over the trough edges by trough to trough stabilization, torsional stiffness or support spacing and rigidity.

4. Deflection.

a) Vertical. The maximum deflection shall be less than or equal to L/1000, where L equals the unsupported trough length in inches. The maximum vertical deflection, measured at the mid-point between supports shall not exceed 1/8 inch.

b) Horizontal. The maximum deflection under full lateral loading shall be less than or equal to D/100, where D is equal to the trough depth in inches. Under no circumstances shall the maximum deflection exceed 1/8 inch.

c) Bottom. The maximum bottom deflection shall be less than or equal to W/100, where W equals the trough width in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

D. Trough joints shall be designed for + 1/8 inch thermal expansion or contraction without stressing the structure. The trough shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion (contraction) between the trough and tank/support materials. Each trough shall consist of a maximum of four (4) sections, and shall be connected with a watertight seal. Trough color shall be blue green translucent and include an ultraviolet light blocking agent added to the resin.

E. An integrally molded water stop shall be provided on the discharge end of each trough. The closed end of the trough shall be integrally molded during trough construction to a minimum of 3/8 inch thickness and arranged for bolting to the basin. Trough intermediate supports shall be 316 stainless steel and connected to the overhead concrete support beams. Each intermediate and rear support shall provide means of vertical adjustment. All support hardware, metal components and angles shall be 316 (or 316L) stainless steel and shall be provided by trough manufacturer. Carbon steel, brass, bronze and aluminum inside the filter box shall not be acceptable. The manufacturer shall submit details of supports with calculations showing vertical and horizontal deflection, support calculations and physical properties of the FRP.

D. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with 3 ounces or more of chopped strand glass laminate in a minimum of two (2) layers. Final laminate thickness shall be within a tolerance of plus 1/16-inch or minus "O" of minimum laminate thickness. Void content of the complete laminate shall not exceed 2-1/2 percent of laminate volume.

E. The manufacturer shall certify that troughs and the testing of the trough materials is in complete compliance with the latest ASTM Standards. Copies of the certified test reports on the troughs shall be submitted to the Engineers in addition to the required calculations and physical properties stated in these Specifications.

PART 3 -- EXECUTION

3.01 FABRICATION

A. All cut edges and holes shall be sealed with a compatible resin.

B. All FRP items shall conform to the dimensions indicated on the Drawings.

C. The laminate thickness shall be ¼ inch, or greater, where required in high stress areas. Glass reinforcement shall consist of chemically bonded surfacing mat of Type C, 10-20 mils thick or chopped strand or chopped strand mat of Type E glass.

D. The inner surface of the trough shall be smooth and reinforced with glass surfacing mat. The outer surface shall be chopped strand glass laminate with a minimum of two layers. Void content of complete laminate shall not exceed 2-1/2 percent of total laminate volume.

E. Thickness at locations of supports such as saddles, end flanges, and blind ends shall be at least 11/2 times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of the specification.

F. Connection to the gullet wall shall be via fixed, adjustable flanged end bolted to the wall.

3.02 HANDLING, TRANSPORTING, AND STORING

A. All FRP items shall be properly packed, labeled and stored in accordance with Divisions 1 and 11, and where directed by the Contractor. Each trough shall be temporarily braced in each end with an approved type of internal spider or wooden blank to maintain its shape and prevent distortion during shipping and installation.

B. The Contractor shall take precautions as required to prevent damage or warpage of any stored or installed component. Troughs shall be handled carefully to prevent damage and shall be stored on platforms supported clear of the ground. Only sound, undamaged units shall be installed. Units damaged before final completion of the work shall be removed and replaced with undamaged units by the Contractor without additional expense to the Owner.

C. In the event any material, equipment, or supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace the same without additional cost to the Owner.

3.03 INSTALLATION

A. Installation of all items shall be according to manufacturer's instructions, unless otherwise noted.

B. Exposed threads of FRP bolts shall be sealed with a compatible resin after installation of the bolts. Where bolts are attaching removable items, the exposed threads shall be sealed with a light coat of polyurethane sprayed onto the threads.

C. All stainless steel threaded components shall be lightly coated with an anti-seize compound suitable for use in potable water and in conformance with the requirements of NSF 61.

D. Weirs and baffles shall be installed in full accordance with the manufacturer's recommendations. Joints between weir plates and concrete and butting weir plates shall be watertight. The Contractor shall seal all weirs with caulk after weirs are set, checked for level, and are within specified tolerances.

E. The weir edges shall be level, straight, and with not more than 1/8-inch variation from level throughout the entire length.

F. Each trough shall be within + 1/16 inch of specified elevation

3.04 FIELD TESTING

A. The costs of all work and materials to correct deficiencies revealed during testing and the cost of retesting shall be borne by Contractor. Tests shall be repeated following any corrective measures.

B. Wash water trough weirs shall be tested by filling the trough and contactor with water to confirm that the specified vertical deflections are not exceeded. Troughs shall be tested for conformance with level requirements by raising the water level in each contactor to the elevation of the trough weirs.

- END OF SECTION -

# SECTION 13400

# FILTER UNDERDRAIN SYSTEM

## PART 1 -- GENERAL

### 1.01 WORK INCLUDES

A. The Contractor shall furnish, install, and place into satisfactory operation the filter underdrain and air grid system complete with all necessary anchors and appurtenances required to provide a complete installation as shown on the Contract Drawings and as specified herein. One manufacturer shall take responsibility for both the filter underdrains and the air scour system furnished under this section.

### 1.02 RELATED WORK

A. Section 01300 – Submittals

B. Section 05050 – Metal Fastening

C. Section 11000 - Equipment General Provisions

D. Section 13221 – Filter Media

### 1.03 MANUFACTURERS

A. The Contractor shall furnish and install dual parallel lateral type underdrain as manufactured by Roberts Water Technologies, Inc. only.

B. Filter media and support gravel shall be furnished as specified in Section 13221.

### 1.04 SUBMITTALS

A. The Contractor shall submit to the Engineer for review detailed shop drawings of all filter components in accordance with Section 01300 - Submittals. Shop drawings shall include:

1. Performance Affidavit in accordance with Section 11000.

2. Overall plans and sections, materials of construction, installation instructions and recommendations and leveling requirements for underdrain system. Submittal data shall include grout mix design, and underdrain anchoring details.

3. Complete maldistribution calculations and head loss data for water flow through the underdrain header.

4. Calculations of anchorage system to resist the conditions specified in Part 2 herein.

5. NSF 61 Certification.

6. Field test reports.

7. Reports of manufacturer site visits.

1.05 MANUFACTURER'S RESPONSIBILITY

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions and Division 1. The services of the manufacturer's representative shall be provided as follows:

1. One (1) trip of four (4) days duration to supervise and check complete installation of the filter underdrain system in the first filter cell where an underdrain system is installed.

2. One (1) trip of two (2) days duration to supervise and check installation of filter media.

3. One (1) trip of two (2) days to perform final checking and certification of the installation and to instruct the Owner's personnel in proper operation and maintenance of the equipment.

B. A written report covering the representative's findings and installation approval shall be mailed directly to the Owner covering all inspection and outlining in detail any deficiencies noted.

C. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with Section 01300 and 11000.

PART 2 -- MATERIALS

2.01 GENERAL REQUIREMENTS

A. The filter underdrain system shall be designed in accordance with the dimensions and layout shown in the Contract Drawings and shall cover the entire filter floor area. It shall be suitable for water backwash and shall be designed to ensure long-term stability in its operating characteristics. The underdrain system shall be designed to resist plugging and all other effects which would in time cause loss of hydraulic efficiency or effectiveness of its operation. Materials used in the filter underdrain system shall conform to the requirements specified herein.

B. The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following flow conditions:

1. Design average filtration rate: 4.2 gpm/ft$^2$

2. Design maximum filtration rate: 5.0 gpm/$ft^2$

3. Upflow of backwash water at up to 20 gpm/$ft^2$ with total headloss not more than 20 inches of water

C. The filter underdrain system shall be designed for installation to produce near-uniform water flow throughout the filter cell. There shall be no localized areas with flow rates which would cause mounding, lateral displacement, or other disturbances in the media or media support layers.

D. Performance

1. The underdrain system shall provide uniform water backwash over the entire surface of the filter. Maldistribution of backwash water flow shall not exceed $\pm$ 5 percent of average gpm per square foot.

2. The underdrain shall collect filtered effluent at the rate of 5 gpm/sf with a total headloss through the underdrain orifices of 2.5 inches of water or less. At the collection rate of 8 gpm/sf, headloss in the underdrain shall not exceed 6 inches of water.

2.02 FILTER UNDERDRAIN SYSTEM

A General Requirements

1. The filter underdrain system shall be as shown in the Contract Drawings.

B. Materials used in the filter underdrain system shall conform to the requirements specified herein and shall be NSF approved for use in water treatment.

C. The filter underdrain system shall be of the dual lateral type, whereby feeder and compensatory laterals are provided within a single block or pre-fabricated lateral. The blocks or laterals shall be self-contained. The flow metering elements shall consist of an arrangement of orifices properly sized and located, between the feeder and compensatory laterals, and between the compensatory laterals and top of the blocks. The entrance, transport, and orifice losses, and the placement of the orifices shall be coordinated to produce uniform water flow throughout the filter cell at all specified flow conditions. The number and size of the orifices shall be uniform throughout the filter cell. The orifices shall be sized as required to introduce necessary metering headlosses, but shall be sufficiently large to prevent clogging.

D. The filter underdrain system shall also be designed to withstand a net downward loading of not less than 2,400 psf, plus its own dead weight.

E. The individual blocks used in the system shall be of a suitable impervious, high strength, high density, completely corrosion resistant polyethylene or plastic material having uniform smooth surfaces and all orifices properly deburred. The blocks shall have ridges and pockets for structural rigidity and to key into surrounding grout. The blocks shall either be mechanically joined or prefabricated full length laterals. Mechanically joined blocks shall form a continuous lateral equivalent to the length of the filter cell and the joints shall be

gasketed, bell-and spigot type with internal registers, and be air and water tight. Prefabricated full length laterals shall be supplied in the required length of the filter cell.

F. All equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which it is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.

G. All grout used in installing the blocks shall be as specified in Section 03600.

H. PVC shall be high-strength, completely inert, resistant to erosion and corrosion.

I. All exposed metals, anchor bolts, handrail bolts, washers, clips, clamps, fasteners of any type, etc. shall be constructed of 316 stainless steel.

J. Underdrains shall be anchored with anchor bolts along the entire length of the lateral and sufficient anchorage shall be provided to resist buoyant and dynamic forces during operation. Anchor bolts shall conform to the requirements specified herein and Section 05050. Systems that use any anchoring system that cannot be tested in the field at the pull strength specified herein will not be permitted. The filter underdrain system, when installed and anchored, shall be designed to withstand a burst pressure equal to twice the maximum pressure experienced at maximum backwash rates. No credit shall be taken for the weight of the filter media. All anchor bolts shall be a minimum of 1/2-inch diameter. All adhesive anchors shall be epoxy type chemical bond anchor bolts and must be set according to instructions provided by the manufacturer and must be installed into the parent filter box concrete. Anchors that only extend into the leveling grout will not be permitted. Anchorage system shall be capable of exceeding the structural requirements of supporting a vertical downward load of 2,400 pounds per square foot and a vertical upward load of 1,600 pounds per square foot.

2.03 AIR GRID SYSTEM

An air grid scour system shall be provided and installed as shown on the drawings. Air Grid System shall be manufactured by Roberts. The unitized air diffusers, piping and structure shall be 316 Stainless Steel and designed to provide an Air Flow Rate: 3 - 5 scfm/square foot (54.5 - 90.9 $m^3/hr/m^2$) with standard orifice spacing of 6" on center.

## PART 3 -- EXECUTION

3.01 UNDERDRAIN SYSTEM INSTALLATION

A. The equipment shall be installed and field tested by the Contractor in accordance with the instructions and drawings of the manufacturer and Section 11000, Equipment-General.

B. The Contractor shall arrange for the equipment manufacturer to furnish the services of a qualified service person with at least three years of experience who is regularly involved in the inspection, installation, start-up, troubleshooting, testing, maintenance, and operation of filter underdrain systems. The service person shall:

1. Witness and check installation of the system.

2. Assist the Contractor in conducting field tests and preparing a written report as specified below.

3. Witness and check start-up of the system.

4. Assist the Contractor in making adjustments and modifications as necessary to optimize operation of system components.

5. Troubleshoot and correct any problems with the underdrain system that are noted during tests and start-up.

6. Submit written certification that the system has been properly installed, tested, and adjusted including date of final acceptance test, as well as a listing of all persons present during the tests.

7. Investigate and supervise correction of any operating problems that may arise up to the end of the guarantee period of the equipment.

8. Such services shall be furnished at no additional cost to the Owner.

C. The underdrain shall be securely anchored against all testing and operating conditions. The Contractor shall obtain from the underdrain manufacturer such written installation details and recommendations as are necessary to interface the filter underdrain system with all surrounding structures, including requirements for grouting keys and pockets, dowels, support ledges and anchorage. The Contractor is cautioned that such installation details are not shown on the Contract Drawings.

D. The Contractor shall take precautions as required to prevent breakage or warpage of any stored or installed underdrain component. Underdrain components shall be handled carefully to prevent damage and shall be stored on platforms supported clear of the ground. Only sound, undamaged units shall be installed. Units damaged before final completion of the work shall be removed and replaced with undamaged units by the Contractor without additional expense to the Owner.

E. Contractor shall take all necessary precautions recommended by the underdrain manufacturer in writing and as specified herein to ensure that the underdrain system and piping connected thereto is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter shall be removed by brooming down, vacuuming and water flushing. Care shall be taken as necessary to prevent grout from extruding into any flow passages or ports, and any such grout shall be removed. As installation progresses, underdrain sections partially completed shall be protected with heavy building paper, masking tape, or other means to maintain cleanliness. Cleanliness shall be maintained until final placement of filter media.

F. Underdrain Installation

1. 316 stainless steel anchor rod shall be set in the floor slab on both sides of the distribution flume, and underdrain blocks or laterals along the length of the lateral.

2. The anchor rods shall be installed in a way that assures proper alignment and elevation. The underdrain blocks in each filter shall be set in at least a 1/2" deep bed of cement grout covering the entire filter floor slab.

3. The ends of each row of blocks shall be closed by means of polystyrene plates furnished for this purpose by the supplier of the blocks. After the underdrain blocks have been arranged and anchored in substantially level rows, all spaces between adjoining rows of blocks, and rows of blocks in the filter walls shall be filled with non-shrink grout so that the finished underdrain system shall comprise a totally sealed, level, and firmly secured structure. All underdrain blocks that span flumes shall be provided with strips to retain the grout. Adequate care shall be taken to prevent any grout from entering the orifices.

4. Following the completion of installation of the underdrain system, it shall be allowed to set for three (3) days at an ambient air temperature of at least 40 degrees Fahrenheit before applying internal water pressure, or any substantial external forces. After the minimum setting period, the system shall be completely cleaned and washed free of all debris, and any other loose materials. Thereafter, the general structural integrity as well as the uniformity of hydraulic distribution shall be verified by imposing the maximum design backwash rate of flow upon the completed underdrain system.

5. The installation of the filter underdrain system shall be undertaken under the supervision of an experienced field service engineer from the underdrain manufacturer.

3.02 FIELD TESTING OF UNDERDRAIN SYSTEM

A. The Contractor shall conduct all testing specified herein and recommended by the manufacturer, and shall furnish all material, instrumentation, temporary pumps, personnel, etc. for conducting tests as specified herein. Finished water shall be used for all field tests in this section. The costs of all work and materials to correct deficiencies revealed during testing and the cost of retesting shall be borne by Contractor.

B. After the adhesive manufacturer's recommended cure time has elapsed, pull tests shall be performed on 25% of the anchor bolts in one filter box prior to installing underdrains in the next filter box. The Engineer shall select the exact bolts for testing and shall witness the test. For testing, anchor bolts shall be proof tested to 1.33 times the allowable load as specified herein. No visible signs of movement of the anchor bolts/dowels is permitted under this load. Upon receiving satisfactory results from these tests, installation may commence on the next filter box underdrain and anchors. If satisfactory results are not obtained, Contractor shall make whatever provisions necessary to reinstall the failed anchors and achieve the specified pull strength. Testing may continue in the next filter cell on 25% of the anchor bolts. After satisfactory results are obtained on 25% of the anchor bolts in one cell, test a minimum of 10% of the anchors, as selected by the Engineer, in the remaining filter boxes as previously described.

C. The underdrain system in each filter shall be flooded with water to the top of the metering orifices to ascertain that the level tolerance is as specified herein. Measurements of level tolerance shall be collected at representative locations within the filter and reported to the Engineer.

D. Three days or more after grouting has been completed, and before media has been placed, the underdrains shall be tested with water. Ensure the piping system including washwater line is free of air. Slowly fill the filter box from the bottom at approximately 2 gpm/sf.

E. When water level reaches half the height of the underdrain system, discontinue backwash and drain until the water falls below the underdrain surface. Start a slow backwash at 6 gpm/sf and using manometers, or other field method approved by the Engineer. If distribution pattern is even, raise the backwash rate in 5 gpm/sf increments following 6-inches of rise. Measure and record rate of rise for each flow rate. Verify distribution across contactor area is within 5% of design low and high backflow rate at individual orifices. Maintain rate at 20 gpm/sf for a minimum of 2 minutes. Check for unusual flow disturbances, dead spots or boils. Drain water to below underdrains and visually inspect bottom. Repeat test three times. Testing using rise rate isolation test boxes and test method as approved by the Engineer will be acceptable in lieu of the above described test method.

F. The Contractor shall take all necessary measures to correct any deficiencies revealed by these tests and shall repeat the specified tests until such deficiencies are corrected.

- END OF SECTION -

# SECTION 13450

# DISINFECTION OF WATER TREATMENT FACILITIES

## PART 1 -- GENERAL

### 1.01 GENERAL

A. The Contractor shall clean and disinfect the water treatment facilities including all filters, tanks, equipment, and related piping and valves prior to placing the systems into service in accordance with the regulations of the Kentucky Division of Water (KDOW), the requirements of Kentucky American Water, and as specified herein.

B. Before being placed into service all new or modified potable water systems shall be disinfected in accordance with the requirements of these Specifications.

### 1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all work hereunder shall conform to the applicable requirements of the following documents to the extent that the requirements therein are not in conflict with the provisions of this Section.

1. AWWA C652 – Disinfection of Water Storage Facilities

2. AWWA B300 – Hypochlorites

### 1.03 SUBMITTALS

A. Submit procedures for completing the disinfection of the plant facilities listed above, including the proposed methods of storing, handling and dispensing the disinfectant.

B. Submit a "Record of Compliance" stating that bacteriological testing had been accomplished and certifying that the water is free of coliform bacteria contamination. Results of this testing shall meet KDOW requirements.

C. Testing and disinfection shall be accomplished in the presence of the Engineer.

## PART 2 -- PRODUCTS

### 2.01 WATER SUPPLY

A. The Owner shall provide reasonable quantities of water necessary for initial flushing, testing, and disinfection of all facilities associated with this Project. Should testing indicate that additional disinfection is required, the Contractor is responsible for providing water for all subsequent disinfection and testing.

B. The costs for all chemical equipment (pumps, testing kits, etc.) associated with leakage testing, cleaning, or rinsing of the facilities shall be the responsibility of the Contractor. The Owner has limited facilities for potable water use and reserves the right to limit the volume of water used per day and the times of the day when the Contractor is permitted to use

water for the project. Disposal of water for leak testing, cleaning and rinsing shall be the responsibility of the Contractor and shall be performed in accordance with all federal, state and local requirements in such a manner as to cause no adverse environmental effects such as fish kills or erosion.

2.02 CHEMICAL

A. The Contractor is responsible for all chemicals and chemical feed pumps required for disinfection.

2.03 BACTERIOLOGICAL TESTING

A. The Owner shall furnish bacteriological testing for verification of disinfection procedures.

PART 3 -- EXECUTION

3.01 GENERAL

A. Materials

1. Chlorine for disinfection shall be in the form of liquid chlorine, sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

2. Liquid chlorine shall be in accordance with the requirements of AWWA B301. Liquid chlorine shall be used only:

a. In combination with appropriate gas flow chlorinators and ejectors.

b. Under the direct supervision of an experienced technician.

3. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of AWWA B300 and AWWA C652.

B. Scheduling

1. The Contractor shall provide the Engineer with a detailed flushing, testing, and disinfection plan for approval. The Engineer reserves the right to adjust, modify, and/or alter the proposed plan to serve the best interests of the Owner.

2. The Contractor shall give the Owner at least 1 week advance notice of his intent to begin flushing, testing and disinfecting any portion of the system.

3. All flushing, testing and disinfection shall be witnessed by the Engineer and a representative of the Owner. The Contractor shall coordinate all work with the Engineer at a time mutually agreeable to the Owner and shall give at least 24 hours advance notice prior to performing any work.

C. Flushing

1. The Contractor shall flush all facilities described herein in accordance with these Specifications. The times for flushing shall be coordinated with the Owner.

2. The Contractor shall prevent excessive water from flowing onto private property. Care shall be exercised to prevent the water from entering trenches or wetting backfill material. All materials required for flushing shall be furnished by the Contractor.

D. Filter and Clearwell Filling

1. All pipelines and tanks shall be filled slowly either through an existing valve or through taps. Special care shall be exercised in loading lines and filling the tanks to prevent damage. The Contractor shall coordinate with the Owner the operation of all existing valves.

E. Disinfection

1. The filters shall be disinfected in accordance with the procedures described in AWWA C652, Disinfection of Water Storage Facilities and as specified herein. After placement and skimming of the filter media and before the filter is placed in service, the entire depth of the filter, media, underdrain system, and associated piping in each filter shall be disinfected according to the following procedure unless alternate procedures are required by KDOW or the Owner. The Contractor shall submit the proposed method to the Engineer prior to performing the work.

   a. With all other filter valves closed, the filter shall be filled with finished water pumped to the filter by the Contractor. Sufficient disinfectant shall be added to the incoming water to achieve a level of 50 mg/l of free chlorine in the disinfecting water. This level of chlorine shall be maintained during the disinfection process.

   b. The disinfection process shall proceed for not less than twenty-four (24) hours.

   c. Upon completion of disinfection and satisfactorily passing bacteriological testing by the Owner, the filter contents shall be discharged to the plant drain system and properly dechlorinated by the Contractor in a manner acceptable to the Owner and Engineer.

2. The tanks shall be disinfected in accordance with the procedures described in AWWA C652, Disinfection of Water Storage Facilities and as specified herein. Disinfection shall also be in accordance with the requirements of the KDOW and the Owner. The Contractor shall submit the proposed method to the Engineer prior to performing the work.

   a. The Contractor shall wash down the interior of the tanks to remove all dirt and loose materials prior to disinfection. Potable water shall be used to clean the tank. All equipment, including brooms, brushes, spray equipment and workmen's boots shall be disinfected before they are used to clean the tank. Prior to both testing and disinfecting, tanks shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. All water, dirt and foreign material accumulated during this cleaning operation shall be discharged from the structure.

b. Disinfection shall be accomplished after the tanks have been flushed, if applicable, and passed the hydrostatic test. Disinfection may also occur concurrently with leakage testing. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or KDOW and/or the Owner until the minimum residual chlorine concentration has been reached.

c. The Contractor shall be responsible for the discharge of water from the tanks after completion of the hydrostatic testing and disinfection work. Disposal of the water shall be in accordance with Federal, State of Kentucky and local requirements.

3. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection.

4. The filters and tanks shall be disinfected by any one of the methods of chlorination outlined herein and in Section 4 of AWWA C652.

a. Method One

The tanks shall be filled to the overflow level with potable water. Chlorine (as calcium hypochlorite, sodium hypochlorite, or liquid chlorine) shall be added to the water to provide a free chlorine residual in the tanks of not less than 10 mg/L at the end of the appropriate retention period. If calcium hypochlorite is used, it shall be placed in the tanks on a dry surface prior to filling and shall be located such that inflowing water will ensure a current circulating through the chemical to dissolve it during tank filling. If sodium hypochlorite is used, it shall be added by a chemical-feed pump to the influent water line to ensure uniform addition and adequate mixing. The sodium hypochlorite shall be added during the tank filling when the water depth is no less than 1 foot and no more than 3 feet. If liquid chlorine is used, it shall be added by chemical-feed pump to the influent water line such that a uniform chlorine concentration is achieved during the entire filling process. The Contractor shall test and record the free chlorine residual every hour. The free chlorine residual shall not exceed 15 mg/L at any time during this chlorination process.

After the tanks have been filled to the overflow level and the free chlorine residual is 10 mg/L, they shall stand full for at least (1) a 6-hour retention period if liquid chlorine was used for disinfection or (2) a 24-hour retention period if either sodium hypochlorite or calcium hypochlorite was used for disinfection. During this retention period, the Contractor shall continue to test and record the free chlorine residual every hour. The free chlorine residual concentration shall be maintained at no less than 10 mg/L. After the appropriate retention period, the tanks shall be dechlorinated either by use of a reducing agent or by nature (i.e. let the tanks sit until the chlorine residual drops naturally to 2 mg/L). The Contractor shall be responsible for obtaining and paying for all chemicals used for chlorination and dechlorination. The Owner will determine whether dechlorination is performed by nature or chemical reducing agents or a combination of both. After analyses of the water for satisfactory bacteriological quality, the tanks may be placed in service.

b. Method Two

All interior surfaces of the tanks shall have applied a chlorine solution containing at least 200 mg/L of free available chlorine. The chlorine solution shall be applied with either spray equipment or brushes. The disinfecting solution shall be prepared by adding one ounce of calcium hypochlorite powder (70 percent) or 4.5 liquid ounces of sodium hypochlorite solution (12.5 percent) to each 26 gallons of water. The surfaces to be disinfected shall remain in contact with the strong chlorine solution for at least 30 minutes, after which potable water shall be admitted, the drain piping shall be purged of all highly chlorinated water, and the tanks shall be filled to the overflow level. The full tanks shall be allowed to stand for 8 hours, after which, if a chlorine residual is less than one milligram per liter, additional hypochlorite shall be added, the tanks shall be allowed to stand for an additional 8 hours, and the chlorine residual shall be rechecked. The tanks shall then be tested for satisfactory bacteriological quality before placing the tanks in service.

c. Method Three

The tanks shall be filled to the overflow level with potable water to which enough chlorine has been added to produce an initial chlorine concentration of 50 mg/L in the full tank. The full tank should stand for 24 hours; however, in no case shall it stand less than 6 hours. At the end of the holding period, the chlorinated water shall be drained to waste, and the tanks shall be refilled with potable water and tested for satisfactory bacteriological quality before placing the tanks in service. As an alternative to wasting the water, the Contractor may treat the water with an NSF-approved agent to reduce the chlorine residual to a maximum of 2 mg/L.

5. Any equipment used either for disinfection or dechlorination shall be either new or previously used only for disinfection or dechlorination. All chemicals used for disinfection and dechlorination shall be NSF-approved for use in potable water.

6. The Contractor shall advise the Owner when the tank or pipe is ready for bacteriological sampling. The disinfected tanks shall be sampled by the Contractor in accordance with AWWA C652.

7. The chlorine disinfection solution shall be thoroughly flushed out prior to placing the tanks in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant or fish life. An NSF-approved reducing agent may be added to the highly chlorinated water to reduce the chlorine residual to an acceptable level. A water disposal plan shall be submitted to the Engineer prior to tank cleaning, filling or disinfection. The Contractor shall pay all civil penalties, fines, costs, assessments, etc., associated with any discharge of spent chlorine solution associated with the Contractor's work. Chlorine residual tests will be made after flushing to assure that the chlorine residual is not in excess of 1 ppm.

8. The Contractor shall have no monetary compensation from the Owner for the inability of the Owner to provide adequate water at the proposed time of disinfection. Compensation is limited to an extension of time to the Contract only.

3.04 TESTING

A. After the potable water system has been disinfected and filled with potable water, the Owner will sample and test water samples from within the system to determine bacterial quality. If results of the tests are not acceptable, the disinfection of the system shall be repeated by the Contractor until acceptable water quality is provided.

3.05 DISINFECTION OF PLANT PIPING AND VALVES

A. Disinfection of piping and valves shall be performed by the Contractor as specified under Section 15000 – Basic Mechanical Requirements. Valves shall be disinfected in a manner similar to the disinfection process described for piping in Section 15000.

- END OF SECTION -

# SECTION 15000

# BASIC MECHANICAL REQUIREMENTS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish and install to the required line and grade, all piping together with all fittings and appurtenances, required for a complete installation. All piping located outside the face of structures or building foundations and all piping embedded in concrete within a structure or foundation shall be considered exterior piping.

B. The Contractor shall furnish and install fittings, couplings, connections, sleeves, adapters, harness rods and closure pieces as required to connect pipelines of dissimilar materials and/or sizes herein included under this Section and other concurrent Contracts for a complete installation.

C. The Contractor shall furnish all labor, materials, equipment, tools, and services required for the furnishing, installation and testing of all piping as shown on the Drawings, specified in this Section and required for the Work. Piping shall be furnished and installed of the material, sizes, classes, and at the locations shown on the Drawings and/or designated in this Section. Piping shall include all fittings, adapter pieces, couplings, closure pieces, harnessing rods, hardware, bolts, gaskets, wall sleeves, wall pipes, hangers, supports, and other associated appurtenances for required connections to equipment, valves, or structures for a complete installation.

D. Piping assemblies under 4-inch size shall be generally supported on walls and ceilings, unless otherwise shown on the Drawings or ordered by the Engineer, being kept clear of openings and positioned above "headroom" space. Where practical, such piping shall be run in neat clusters, plumb and level along walls, and parallel to overhead beams.

E. The Contractor shall provide taps on piping where required or shown on the Drawings. Where pipe or fitting wall thicknesses are insufficient to provide the required number of threads, a boss or pipe saddle shall be installed.

F. The work shall include, but not be limited to, the following:

1. Connections to existing pipelines.

2. Test excavations necessary to locate or verify existing pipe and appurtenances.

3. Installation of all new pipe and materials required for a complete installation.

4. Cleaning, testing and disinfecting as required.

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### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 1, General Requirements

B. Division 2, Sitework

C. Division 9, Finishes

D. Division 11, Equipment

E. Division 16, Electrical

1.03 MATERIAL CERTIFICATION AND SHOP DRAWINGS

A. The Contractor shall furnish to the Engineer a Material Certification stating that the pipe materials and specials furnished under this Section conform to all applicable provisions of the corresponding Specifications. Specifically, the Certification shall state compliance with the applicable standards (ASTM, AWWA, etc.) for fabrication and testing.

B. Shop Drawings for major piping (2-inches in diameter and greater) shall be prepared and submitted in accordance with Section 01300 – Submittals. In addition to the requirements of Section 01300 – Submittals, the Contractor shall submit laying schedules and detailed Drawings in plan and profile for all piping as specified and shown on the Drawings.

C. Shop Drawings shall include, but not be limited to, complete piping layout, pipe material, sizes, class, locations, necessary dimensions, elevations, supports, hanger details, pipe joints, and the details of fittings including methods of joint restraint. No fabrication or installation shall begin until Shop Drawings are approved by the Engineer.

## PART 2 -- PRODUCTS

2.01 GENERAL

A. All specials and every length of pipe shall be marked with the manufacturer's name or trademark, size, class, and the date of manufacture. Special care in handling shall be exercised during delivery, distribution, and storage of pipe to avoid damage and unnecessary stresses. Damaged pipe will be rejected and shall be replaced at the Contractor's expense. Pipe and specials stored prior to use shall be stored in such a manner as to keep the interior free from dirt and foreign matter.

B. Testing of pipe before installation shall be as described in the corresponding ASTM or AWWA Specifications and in the applicable standard specifications listed in the following sections. Testing after the pipe is installed shall be as specified herein.

C. Joints in piping shall be of the type as specified in the appropriate Piping System Schedule in Section 15390, Schedules.

D. ALL BURIED EXTERIOR PIPING SHALL HAVE RESTRAINED JOINTS FOR THRUST PROTECTION UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS. ALL EXPOSED EXTERIOR PIPING SHALL HAVE FLANGED JOINTS, UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.

E. The Drawings indicate work affecting existing piping and appurtenances. The Contractor shall excavate test pits as required of all connections and crossings which may affect the Contractor's work prior to ordering pipe and fittings to determine sufficient information for

ordering materials. The Contractor shall take whatever measurements that are required to complete the work as shown or specified.

2.02 WALL PIPES

A. Where wall sleeves or wall pipes occur in walls that are continuously wet on one or both sides, they shall have water stop flanges at the center of the casting or as shown on the Drawings. Ends of wall pipes shall be flange, mechanical joint, plain end, or bell as shown on the Drawings, or as required for connection to the piping. Wall pipes shall be of the same material as the piping that they are connected to. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange. Unless otherwise shown on the Drawings, waterstop flanges shall conform to the minimum dimensions shown below:

| Pipe Size | Waterstop Flange Diameter | Waterstop Flange Thickness |
|---|---|---|
| 4" - 12" | OD + 3.10" | 0.50" |
| 14" - 24" | OD + 4.15" | 0.75" |
| 30" - 36" | OD + 4.50" | 1.00" |
| 42" - 48" | OD + 5.00" | 1.25" |
| 54" | OD + 5.90" | 1.50" |

2.03 SLEEVES

A. Unless shown otherwise, all piping passing through walls and floors shall be installed in sleeves or wall castings accurately located before concrete is poured, or placed in position during construction of masonry walls. Sleeves passing through floors shall extend from the bottom of the floor to a point 3 inches above the finished floor, unless shown otherwise. Water stop flanges are required on all sleeves located in floors or walls which are continually wet or under hydrostatic pressure on one or both sides of the floor or wall.

B. Sleeves shall be cast iron, black steel pipe, or fabricated steel in accordance with details shown on the Drawings. If not shown on the Drawings, the Contractor shall submit to the Engineer the details of sleeves he proposes to install; and no fabrication or installation thereof shall take place until the Engineer’s approval is obtained. Steel sleeves shall be fabricated of structural steel plate in accordance with the standards and procedures of AISC and AWS. Steel sleeve surfaces shall receive a commercial sandblast cleaning and then be shop painted in accordance with Section 09900 – Painting.

C. When shown on the Drawings or otherwise required, the annular space between the installed piping and sleeve shall be completely sealed against a maximum hydrostatic pressure of 20 psig. Seals shall be mechanically interlocked, solid rubber links, trade name "Link-Seal", as manufactured by the Thunderline Corp., Wayne, Michigan, or equal. Rubber link, seal-type, size, and installation thereof, shall be in strict accordance with the manufacturer's recommendations. For non-fire rated walls and floors, pressure plate shall be glass reinforced nylon plastic with EPDM rubber seal and 304 stainless steel bolts and nuts. For fire rated walls and floors, two independent seals shall be provided consisting of low carbon steel, zinc galvanized pressure plates, silicon rubber seals and low carbon steel, zinc galvanized bolts and nuts.

D. Cast iron mechanical joint; adapter sleeves shall be Clow # 1429, as manufactured by the Clow Corp., or equal. Mechanical joint adapter sleeves shall be provided with suitable gasket, follower ring, and bolts to effect a proper seal. In general, sleeves installed in walls, floors, or roofs against one side of which will develop a hydrostatic pressure, or through which leakage of liquid will occur, shall be so sealed. If welded waterstop flanges are employed, welds shall be 360 degree continuous on both sides of flange.

2.04 SOLID SLEEVE COUPLINGS

A. Solid sleeve couplings shall be used to connect buried service piping where shown on the Drawings. Solid sleeves shall be ductile iron, long body and shall conform to the requirements of ANSI A21.10 (AWWA C110). Unless otherwise shown or specified, solid sleeve couplings shall be Style A11760 as manufactured by American Cast Iron Pipe Co., or equal.

2.05 FLEXIBLE COUPLINGS

A. Flexible couplings shall be as manufactured by the Red Valve Company and shall consist of a molded reinforced fabric of cotton and natural rubber. Galvanized steel retaining rings shall be furnished. End connections shall match ANSI 125 pound flanges with a minimum pressure rating of 140 psi.

2.06 SLEEVE TYPE COUPLINGS

A. Sleeve type, flexible couplings shall be furnished and installed where shown on the Drawings or otherwise required to resist internal operating pressures. In addition to that specified herein, harnessed, sleeve type flexible couplings shall be provided on all exposed pipe 3 inches and larger in diameter that spans any expansion joint in a building or structure.

B. Materials shall be of high strength steel and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

D. Couplings shall be shop primed with a premium quality primer compatible with the painting system specified in Section 09900 - Painting. Field painting of wetted area shall be done prior to installation.

E. Harnessing

1. Harness couplings to adjacent flanges as shown, specified or otherwise required to restrain all pressure piping.

2. Dimensions, sizes, spacing and materials for lugs, tie rods, washers, and nuts shall conform to the standards for the pipe size, and design pressure specified.

3. No less than two (2) bolts shall be furnished for each coupling.

4. Tie bolts, nuts and washers shall be ASTM A 193, Grade B7 steel or better.

5. Harness rods shall have lengths less than 10 feet between adjacent flanged joints on fittings and shall be coated in accordance with Section 09900 – Painting.

F. Couplings shall be as manufactured by Dresser Industries, Style 38, or equal as required and shown on the Drawings. All couplings shall be provided without interior pipe stop.

2.07 FLANGED ADAPTERS

A. Flanged adapters shall be furnished as required and as shown on the Drawings.

B. All flanged adapters, 12 inches in diameter and smaller, except as shown on the Drawings or directed by the Engineer, shall be locking type flanged adapters.

C. Pressure and service shall be the same as connected piping.

D. Materials shall be cast iron for pipes up to 12 inch diameter and high strength steel for pipes larger than 12 inch diameter.

E. Flanged adapters shall be shop primed with a premium quality primer compatible with the paint system specified in Section 09900 – Painting. Field painting of wetted area shall be done prior to installation.

F. Bolts and nuts shall be alloy steel, corrosion-resistant and prime coated.

G. Flanged coupling adapters larger than 12 inches in diameter shall be harnessed by tying the adapter to the nearest pipe joint flange using threaded rods and rod tabs. The threaded rods and rod tabs shall be as shown on the Drawings.

H. Flanged adapters shall be as manufactured by Dresser Industries, Style 127 or 128, Smith Blair Corporation, or equal.

2.08 MECHANICAL COUPLINGS (SPLIT TYPE - SHOULDERED END)

A. Mechanical couplings (split type-shouldered end) shall be furnished as specified or shown on the Drawings.

B. Materials shall be of malleable iron and couplings shall be rated for the same pressures as the connecting piping.

C. Gaskets shall be rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated.

D. After installation, buried couplings shall receive two heavy coats of an approved coal tar which is compatible with the finish of the coupling. Exposed couplings shall be painted in accordance with Section 09900 - Painting.

E. Couplings shall be as manufactured by Victaulic Company of America, Style 44, or equal.

2.09 TAPPING SLEEVES AND TAPPING SADDLES

A. Tapping sleeves shall be similar to Mueller Outlet Seal, American Uniseal or Kennedy Square Seal. All sleeves shall have a minimum working pressure of 150 psi. All sleeves larger than twelve (12) inches shall be ductile iron. All taps shall be machine drilled; no burned taps will be allowed.

B. Tapping saddles may be used on mains sixteen (16) inches and larger where the required tap size does not exceed one-half the size of the main (i.e. 8-inch tapping saddle for use on a 16-inch main). Tapping saddles shall be manufactured of ductile iron providing a factor of safety of at least 2.5 at a working pressure of 250 psi. Saddles shall be equipped with a standard AWWA C-110-77 flange connection on the branch. Sealing gaskets shall be "O" ring type, high quality molded rubber having an approximate seventy durometer hardness, placed into a groove on the curved surface of the tapping saddles. Straps shall be of alloy steel. The tapping saddle shall be the American tapping saddle, U.S. Pipe tapping saddle, or equal. All taps shall be machine cut, no burned taps will be allowed.

2.10 UNIONS

A. For ductile iron, carbon steel, and grey cast iron pipes assembled with threaded joints and malleable iron fittings, unions shall conform to ANSI B16.39.

B. For copper piping, unions shall have ground joints and conform to ANSI B16.18.

C. For PVC and CPVC piping, unions shall be socket weld type with Viton O-ring.

2.11 THERMOPLASTIC TUBING AND FITTINGS

A. Thermoplastic tubing shall be manufactured from polyallomor tubing. Tubing shall be protected from ultraviolet radiation degradation with a black coating or integral color conforming to ASTM D-1248, Type 1, Class C, Category 3. Fittings and connectors used with thermoplastic tubing shall be the flareless tube type constructed of brass conforming to SAE CA377, SAE CA360 or equal. Brass sleeves shall be used.

B. Assembly of the thermoplastic tubing shall consist of pushing the tubing into the fitting and hand tightening the nut with final tightening with a wrench. Care shall be taken not to overtighten the nut. Plastic tube racks and bend holders shall be provided for holding the tubing in position. Needle valves used with thermoplastic tubing shall be the globe type constructed with a brass body, stem and seat and Buna-N "O"-ring seals. Installation shall be in accordance with the manufacturer's recommendations. Thermoplastic tubing, shall be the Impolene (polyallomor) system and needle valves, fittings and connectors shall be the Poly-Flo with 261 UB Universal Nut and Sleeve system as manufactured by Imperial Eastman, or equal.

2.12 HEAT TRACED PIPING

A. Exposed pipes to be insulated shall also be protected from freezing by heat tracing. Freeze protection heat tracing shall consist of twin 16 AWG copper brass wires with a semiconductor polymer core where electrical resistance varies with temperature. The heat tracing shall have a fluoropolymer outer jacket for corrosion resistance. The heat tracing shall be rated for three (3) watts per foot output, self-regulating with a maximum temperature of 150°F, equal to a Chromalox No. SRL3-1CT383400. Maximum length for

tape shall be 300 feet for each circuit. Temperature controller shall be provided to sense pipe temperature to determine on or off condition of the heat tracing. Temperature control shall be equal to a Chromalox No. RTBC-2-384729. The heat tracing system shall operate on 120 VAC. See Drawings for installation detail. Heat tracing of piping shall be provided as specified in Section 15390 – Schedules.

2.13 FLEXIBLE RESTRAINED EXPANSION JOINTS

A. Restrained expansion joints shall be manufactured of 60-42-10 ductile iron conforming to material and other applicable requirements of ANSI/AWWA C153/A21.53.

B. Each pressure containing component shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the materials requirements of, and tested in accordance with, ANSI/AWWA C213 and shall meet or exceed the requirements of ANSI/AWWA C550.

C. Seals shall conform to the applicable requirements of ANSI/AWWA C111/A21.11.

D. All bolts used in the assemblies shall be stainless steel and shall be coated with a premium quality epoxy.

E. Flanged ends shall comply with ANSI/AWWA C110/A21.10, with the addition of O-ring groove and O-ring.

F. Mechanical joint ends shall comply with ANSI/AWWA C153/A21.53.

G. Restrained expansion joints shall have a minimum pressure rating of 350 psi with a minimum safety factor of 3:1. Each assembly shall be tested at 350 psi before shipment.

H. Restrained expansion joints shall provide for self restraint without tie rods and shall provide for expansion and contraction capabilities cast as an integral part of the end connection.

I. Flexible restrained expansion joints shall allow for 8-inches (+6"-2") minimum expansion.

J. Flexible restrained expansion joints shall consist of an expansion joint designed and cast as an integral part of a ball and socket type flexible joint having a minimum of 15 deflection per ball.

K. Restrained expansion joints shall be the Single Ball or Double Ball FLEX-TEND Expansion Joint as manufactured by EBAA Iron Inc., or equal.

## PART 3 -- EXECUTION

3.01 INSTALLATION

A. All piping shall be installed by skilled workmen and in accordance with the best standard practice for piping installation as shown on the Drawings, specified or recommended by the pipe manufacturer. Proper tools and appliances for the safe and convenient handling and installing of the pipe and fittings shall be used. Great care shall be taken to prevent any pipe coating from being damaged on the inside or outside of the pipe and fittings. All pieces shall be carefully examined for defects, and no piece shall be installed which is known to be cracked, damaged, or otherwise defective. If any defective pieces should be discovered after having been installed, it shall be removed and replaced with a sound one in a

satisfactory manner by the Contractor and at his own expense. Pipe and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are accepted in the complete work. All piping connections to equipment shall be provided with unions or coupling flanges located so that piping may be readily dismantled from the equipment. At certain applications, Dresser, Victaulic, or equal, couplings may also be used. All piping shall be installed in such a manner that it will be free to expand and contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Unless otherwise shown or approved, provided a minimum headroom clearance under all piping of 7 feet 6 inches.

B. Unless otherwise shown or specified, all waste and vent piping shall pitch uniformly at a 1/4-inch per foot grade and accessible cleanouts shall be furnished and installed as shown and as required by local building codes. Installed length of waste and vent piping shall be determined from field measurements in lieu of the Drawings.

C. All excavation shall be made in such a manner and to such widths as will provide ample room for properly installing the pipe and permit thorough compaction of backfill around the pipe. The minimum trench widths shall be in strict accordance with the "Trench Width Excavation Limits" as shown on the Drawings. All excavation and trenching shall be done in strict accordance with these specifications and all applicable parts of the OSHA Regulations, 29CFR 1926, Subpart P.

D. ALL EXCAVATION REQUIRED BY THIS CONTRACT SHALL BE UNCLASSIFIED. NO ADDITIONAL PAYMENT WILL BE MADE FOR ROCK EXCAVATION REQUIRED FOR THE INSTALLATION OF PIPE OR STRUCTURES SHOWN ON THE DRAWINGS.

E. Enlargements of the trench shall be made as needed to give ample space for operations at pipe joints. The width of the trench shall be limited to the maximum dimensions shown on the Drawings, except where a wider trench is needed for the installation of and work within sheeting and bracing. Except where otherwise specified, excavation slopes shall be flat enough to avoid slides which will cause disturbance of the subgrade, damage to adjacent areas, or endanger the lives or safety of persons in the vicinity.

F. Hand excavation shall be employed wherever, in the opinion of the Engineer, it is necessary for the protection of existing utilities, poles, trees, pavements, or obstructions.

G. No greater length of trench in any location shall be left open, in advance of pipe laying, than shall be authorized or directed by the Engineer and, in general, such length shall be limited to approximately one hundred (100) feet. The Contractor shall excavate the trenches to the full depth, width and grade indicated on the Drawings including the relevant requirements for bedding. The trench bottoms shall then be examined by the Engineer as to the condition and bearing value before any pipe is laid or bedding is placed.

H. No pressure testing shall be performed until the pipe has been properly backfilled in place. All pipe passing through walls and/or floors shall be provided with wall pipes or sleeves in accordance with the specifications and the details shown on the Drawings. All wall pipes shall be of ductile iron and shall have a water stop located in the center of the wall. Each wall pipe shall be of the same class, thickness, and interior coating as the piping to which it is joined. All buried wall pipes shall have a coal tar outside coating on exposed surfaces.

I. JOINT DEFLECTION SHALL NOT EXCEED 75 PERCENT OF THE MANUFACTURERS RECOMMENDED DEFLECTION. Excavation and backfilling shall conform to the requirements of Section 02200 - Earthwork, and as specified herein. Maximum trench widths shall conform to the Trench Width Excavation Limits shown on the Drawings. All exposed, submerged, and buried piping shall be adequately supported and braced by means of hangers, concrete piers, pipe supports, or otherwise as may be required by the location.

J. Following proper preparation of the trench subgrade, pipe and fittings shall be carefully lowered into the trench so as to prevent dirt and other foreign substances from gaining entrance into the pipe and fittings. Proper facilities shall be provided for lowering sections of pipe into trenches. UNDER NO CIRCUMSTANCES SHALL ANY OF THE MATERIALS BE DROPPED OR DUMPED INTO THE TRENCH.

K. Water shall be kept out of the trench until jointing and backfilling are completed. When work is not in progress, open ends of pipe, fittings, and valves shall be securely closed so that no water, earth, or other substance will enter the pipes, fitting, or valves. Pipe ends left for future connections shall be valved, plugged, or capped, and anchored as required.

L. All piping shall be installed in such a manner that it will be free to expand and/or contract without injury to itself or to structures and equipment to which it is connected. All piping shall be erected to accurate lines and grades with no abrupt changes in line or grade and shall be supported and braced against movement, temporary, or permanent. All exposed piping shall be installed with vertical and horizontal angles properly related to adjoining surfaces or pipes to give the appearance of good workmanship. Pipes crossing within a vertical distance of less than or equal to one (1) foot shall be encased and supported with concrete at the point of crossing to prevent damage to the adjacent pipes as shown on the Drawings.

M. The full length of each section of pipe shall rest solidly upon the bed of the trench, with recesses excavated to accommodate bells, couplings, joints, and fittings. Before joints are made, each pipe shall be well bedded on a solid foundation; and no pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Pipe that has the grade or joint disturbed after laying shall be taken up and relaid by the Contractor at his own expense. Pipe shall not be laid in water or when trench conditions are unsuitable for work.

N. Proper and suitable tools and appliances for the safe convenient handling and laying of pipe shall be used and shall in general agree with manufacturer's recommendations.

O. AT THE CLOSE OF EACH WORK DAY THE END OF THE PIPELINE SHALL BE TIGHTLY SEALED WITH A CAP OR PLUG SO THAT NO WATER, DIRT, OR OTHER FOREIGN SUBSTANCE MAY ENTER THE PIPELINE, AND THIS PLUG SHALL BE KEPT IN PLACE UNTIL PIPE LAYING IS RESUMED.

P. During the laying of pipe, each pipe manufacturer shall provide his own supervisor to instruct the Contractor's pipe laying personnel in the correct procedure to be followed.

Q. Ordinarily only full lengths of pipe (as furnished by the pipe manufacturer) shall be used. Exceptions: (closure pieces at manholes and areas where joint deflection is required):

R. For gravity sewer installations, the Contractor shall use a laser device to maintain the trench and pipe alignment. The laser device shall be re-checked for correct elevation and pipe alignment prior to pipe installation if the device is left in the pipe overnight. Corrected invert elevations at each manhole and any adjustments will be coordinated and approved by the Engineer.

S. ALL PIPING SHALL HAVE TYPE "A" BEDDING AS SHOWN ON THE DRAWINGS, UNLESS OTHERWISE SPECIFIED HEREIN OR INDICATED ON THE DRAWINGS.

T. Detector tape shall be installed 12 inches below final grade and directly above all buried potable water piping. The tape shall be blue and silver and shall be clearly and permanently labeled "Water". Detector tape shall be Lineguard III as manufactured by Lineguard, Inc., or equal.

U. AT THE CLOSE OF WORK EACH DAY PIPELINE TRENCHES SHALL BE COMPLETELY BACKFILLED. IN PAVED AREAS THE SURFACE SHALL BE RESTORED TO ALLOW FOR TRAFFIC OVER THE TRENCH DURING NON-WORKING HOURS. UNDER NO CONDITIONS SHALL ANY PIPELINE TRENCH BE LEFT OPEN DURING NON-WORKING HOURS.

3.02 REINFORCED CONCRETE PIPE, CONCRETE CULVERT, AND DRAIN PIPE

A. The laying of reinforced concrete pipe shall conform to the applicable sections of the Concrete Pipe Handbook as published by the American Concrete Pipe Association.

3.03 PRESTRESSED CONCRETE PIPE

A. The laying of prestressed concrete pipe shall be in accordance with the manufacturer's recommendations and shall conform to the applicable sections of AWWA Manual M-9. Prior to assembling the spigot end into the bell end, both ends shall be thoroughly cleaned and the rubber gasket and the bell end of the previously laid pipe shall be coated with vegetable soap furnished by the manufacturer.

B. For each crew that is inexperienced in laying this type of pipe, one reliable man shall be furnished by the manufacturer's representative with and instructed in the use of a set of steel inserts and feeler gauge to be used in determining if the rubber gasket is in proper position prior to the joint being pushed or pulled home. An experienced crew may omit the use of a feeler gauge. In either method of operation, the Contractor shall be responsible for a good, proper and sound joint. Any joint found in later tests to be faulty shall be repaired to the satisfaction of the Engineer.

C. After the pipe is "home" a cloth diaper (minimum 7-inches wide) supplied by the pipe manufacturer shall be placed and wired around the outside of the pipe at the joint. This diaper shall serve as a form for pouring a 1:2 cement-sand grout in the external recess.

D. Great care shall be taken to prevent the concrete core or jacket or the steel bell and spigot rings from being damaged, and any core, jacket or ring damaged in any way shall be repaired or replaced by the Contractor to the satisfaction of the Engineer.

3.04 DUCTILE IRON PIPE

A. Ductile iron pipe (DIP) shall be installed in accordance with the requirements of the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association, and AWWA C600.

B. Where it is necessary to cut ductile iron pipe in the field, such cuts shall be made carefully in a neat workmanlike manner using approved methods to produce a clean square cut. The outside of the cut end shall be conditioned for use by filing or grinding a small taper, at an angle of approximately 30 degrees.

C. UNLESS OTHERWISE APPROVED BY THE ENGINEER, FIELD WELDING OF DUCTILE IRON WILL NOT BE PERMITTED.

3.05 PVC/CPVC AND HDPE PIPE

A. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC) and High Density Polyethylene (HDPE) pipe shall be laid and joints assembled according to the respective manufacturer's recommendation. PVC pipe installation shall comply with applicable sections of the Uni-Bell PVC Pipe Association Recommended Standard Specifications.

B. Plastic piping shall not be installed when the temperature is less then 60 F except as otherwise recommended by the manufacturer and approved by the Engineer.

3.06 CARBON AND STAINLESS STEEL PIPE

A. Installation of steel pipe shall be by skilled workmen and shall conform to the applicable sections of AWWA Manual M-11. Joints for steel piping shall be either screwed, welded, or flanged as shown on the Drawings or as specified.

B. Welding in the field shall be performed only when requested on the shop drawings and permitted by the Engineer for carbon steel pipe. No welding of stainless steel pipe shall be allowed in the field. All field welds shall be radiographically inspected.

C. Installation of the steel casing pipe shall be by skilled workmen and in accordance with the best standard practice for steel pipe installation. Joints for steel casing pipe shall be butt welded.

1. The boring equipment to be used for installing the jacked casing shall be of such size and capacity to allow the boring to proceed in a safe and expeditious manner. The installation of the casing and boring of the hole shall be done simultaneously to avoid cave-ins or settlement and for safety of traffic above.

2. The Contractor shall check the vertical and horizontal alignment of the casing by survey instrument at least once during each four feet of advance, or as directed by the Engineer. Pits shall be well sheeted and braced as necessary for safe and adequate access for workmen, inspectors and materials and shall be of a size suitable to equipment and material handling requirements.

3. Under no conditions shall jetting or wet boring of encasement under pavement be allowed.

4. After installation of the carrier pipe, each end of the casing pipe shall be made watertight with a brick masonry bulkhead. In addition, a Class B concrete cradle shall be provided from each end of the bulkhead to the first pipe joint outside of the bulkhead.

3.07 COPPER PIPE

A. Installation of copper pipe shall be by skilled workman in accordance with the manufacturer's recommendations. Use teflon tape at all fittings unless otherwise required for intended service. Install unions at the connections to each piece of equipment to allow removal of equipment without dismantling connecting piping.

B. Wall sleeves shall be provided for all piping passing through exterior walls and shall be of the same material as the piping to which it is joined. All wall sleeves shall be provided with an acceptable waterstop.

C. The Contractor shall provide hot and cold water mains with branches and risers complete from point indicated on the Drawings running to all fixtures and other outlets indicated. Mains and branches shall be run generally as shown on the Drawings. The Contractor shall provide all interior water piping, branches, and risers as shown on the Drawing and shall make connections to all plumbing fixtures, hose bibs, wall hydrants, and other points requiring water under this and other Divisions of the Specifications.

D. All water mains and branches shall be pitched at least one (1) inch in twenty-five (25) feet toward fixtures. The piping installation shall be arranged so that the entire system can be drained through fixture supply connections.

E. Unions shall be installed at the connections to each piece of equipment to allow for removal of equipment without dismantling connecting piping.

F. Joints 1-1/4 inches and larger shall be made with silver solder. For joints less than 1-1/4 inches and all valves (regardless of size) use 95/5 solder. Soldered joints shall be prepared with a non-corrosive paste flux in accordance with manufacturer's instructions. All joints shall be thoroughly cleaned with emery cloth and reamed out before assembly. Acid core solder will not be permitted.

3.08 POLYPROPYLENE AND POLYVINYLIDENE FLUORIDE PIPE

A. The pipe and fittings shall be of the same material for both inner and outer walls of the pipe.

B. Polypropylene pipe shall be black UV stabilized co-polymer conforming to the requirements of ASTM D-4101. Where used in exterior locations, material shall provide a weathering resistance absent of further coating, covering, or wrapping unless specified herein or shown on the Drawings.

C. Polyvinylidene flouride shall comply with ASTM D-3222. The material shall provide a translucence, thus enabling a visual inspection of liquid in the annular space between the inner and outer walls.

D. Where elastomers are selected by the manufacturer, such selection shall be with regard to the application of the chemical solution to be transported.

E. Pipe and associated fittings shall be rated for not less than 75 psi at 73°F.

F. Double-walled pipe and fittings shall be molded and used throughout. Molded ribs shall maintain permanent alignment of the inner and outer walls of the pipe and fittings.

G. Ends of fittings shall be flush, creating a single plane.

H. Wall thickness of the inner and outer walls of double-walled pipe shall be identical, providing identical pressure ratings.

I. Where shown on the Drawings, a leak detection system of the manufacturer's design shall be supplied, complete with vent pipes, manual drain outlet, and electric float switch. Switch shall be rated for 0.080 amps at 120 VAC.

J. Polypropylene and polyvinylidene flouride pipe shall be laid and joints assembled by skilled workers according to the respective manufacturer's recommendations. Joints shall be butt fusion welded.

K. Plastic piping shall not be installed when the ambient temperature is less than 60°F except as otherwise recommended by the manufacturer and approved by the Engineer.

L. Wall sleeves shall be provided where piping passes through exterior walls. All sleeves shall be provided with an acceptable waterstop.

M. Double walled pipe shall be Asahi/American or equal. Pipe shall be furnished complete with flanges or other appurtenant fittings by the same manufacturer and made especially for use with the double walled pipe.

3.09 JOINTS IN PIPING

A. Restrained joints shall be provided on all pipe joints as specified herein and shown on the Drawings. Restrained joints shall be made up similar to that for push-on joints.

B. Push-on joints include a single rubber gasket which fits into the bell end of the pipe. The gasket shall be wiped clean, flexed and then placed in the socket. Any bulges in the gasket which might interfere with the entry of the plain end of the pipe shall be removed. A thin film of lubricant shall be applied to the gasket surface which will come into contact with the spigot end of the pipe. The lubricant shall be furnished by the pipe manufacturer. The plain end of the pipe, which is tapered for ease of assembly, shall be wiped clean and a thick film of lubricant applied to the outside. The pipe shall be aligned and carefully entered into the socket until it just makes contact with the gasket. The joint assembly shall be completed by entering the pipe past the gasket until it makes contact with the bottom of the socket. The pipe shall be pulled "home" with an approved jack assembly as recommended by the pipe manufacturer. If assembly is not accomplished by reasonable force, the plain end shall be removed and the condition corrected.

C. Flanged joints shall be brought to exact alignment and all gaskets and bolts or studs inserted in their proper places. Bolts or studs shall be uniformly tightened around the joints. Where stud bolts are used, the bolts shall be uniformly centered in the connections and equal pressure applied to each nut on the stud. Pipes in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot.

D. Mechanical joints shall be made up with gaskets, glands and bolts. When a joint is to be made up, the bell or socket and plain end shall be cleaned and washed with a solution or mild soap in water; the gland and gasket shall be slid onto the plain end and the end then entered into the socket until it is fully "home" on the centering ring. The gasket shall then be painted with soapy water and slid into position, followed by the gland. All bolts shall be inserted and made up hand tight and then tightened alternately to bring the gland into position evenly. Excessive tightening of the bolts shall be avoided. All nuts shall be pulled up using a torque wrench which will not permit unequal stresses in the bolts. Torque shall not exceed the recommendations of the manufacturer of the pipe and bolts for the various sizes. Care shall be taken to assure that the pipe remains fully "home" while the joint is being made. Joints shall conform to the applicable AWWA Specifications.

E. Threaded and/or screwed joints shall have long tapered full depth threads to be made with the appropriate paste or jointing compound, depending on the type of fluid to be processed through the pipe. All pipe up to, and including 1-1/2-inches, shall be reamed to remove burr and stood on end and well pounded to remove scale and dirt. Wrenches on valves and fittings shall be applied directly over the joint being tightened. Not more than three pipe threads shall be exposed at each connection. Pipe, in all lines subject to temperature changes shall be cut short and cold sprung into place to compensate for expansion when hot. Joints in all piping used for chlorine gas lines shall be made up with a glycerine and litharge cement. Joints in plastic piping (PVC/CPVC) shall be laid and joints made with compounds recommended by the manufacturer. Installation shall conform to the requirements of ASTM D2774 and ASTM D2855. Unions required adjacent to valves and equipment.

F. Soldered joints shall have the burrs removed and both the outside of pipe and the inside of fittings shall be thoroughly cleaned by proper tools recommended for that purpose. Flux shall be applied to both pipe and inside of fittings and the pipe placed into fittings and rotated to insure equal distribution of flux. Joints shall be heated and solder applied until it shows uniformly around the end of joints between fitting and pipe. All joints shall be allowed to self-cool to prevent the chilling of solder. Combination flux and solder paste manufactured by a reputable manufacturer is acceptable. Unions required adjacent to valves and equipment.

G. Welded joints shall be made by competent operators in a first class workmanlike manner, in complete accordance with ANSI B31.1 and AWWA C206. Welding electrodes shall conform to ASTM A233, and welding rod shall conform to ASTM A25l. Only skilled welders capable of meeting the qualification tests for the type of welding which they are performing shall be employed. Tests, if so required, shall be made at the expense of the Contractor, if so ordered by the Engineer. Unions shall be required adjacent to valves and equipment.

H. Copper joints shall be thoroughly cleaned and the end of pipes uniformly flared by a suitable tool to the bevels of the fittings used. Wrenches shall be applied to the bodies of fittings where the joint is being made and in no case to a joint previously made. Dimensions of tubing and copper piping shall be in complete accordance with the fittings used. No flare joints shall be made on piping not suited for flare joints. Installations for propane gas shall be in accordance with NFPA 54 and/or 58.

I. Solvent or adhesive welded joints in plastic piping shall be accomplished in strict accordance with the pipe manufacturer's recommendations, including necessary field cuttings, sanding of pipe ends, joint support during setting period, etc. Care shall be taken

that no droppings or deposits of adhesive or material remain inside the assembled piping. Solvent or adhesive material shall be compatible with the pipe itself, being a product approved by the pipe manufacturer. Unions are required adjacent to valves and equipment. Sleeve-type expansion joints shall be supplied in exposed piping to permit 1-inch minimum of expansion per 100 feet of pipe length.

J. Dielectric unions shall be installed wherever dissimilar metals are connected except for bronze or brass valves in ferrous piping. Unions shall be provided downstream of each valve with screwed connections. The Contractor shall provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

K. Eccentric reducers shall be installed where air or water pockets would otherwise occur in mains because of a reduction in pipe size.

L. Joints in polypropylene and polyvinylidelene fluoride pipe shall be butt fusion weld. All butt welding shall follow the requirements of ASTM D-2657 and the manufacturer's recommendations.

3.10 FLUSHING AND TESTING

A. All piping shall be properly flushed and tested unless specifically exempted elsewhere in the Specifications or otherwise approved by the Engineer. Air and gas pipelines shall be flushed and tested with compressed air. Gravity sewer piping shall be flushed and tested. All other liquid conveying pipelines shall be flushed and tested with water. The Contractor shall furnish and install all means and apparatus necessary for getting the air or water into the pipeline for flushing and testing including pumps, compressors, gauges, and meters, any necessary plugs and caps, and any required blow-off piping and fittings, etc., complete with any necessary reaction blocking to prevent pipe movement during the flushing and testing. All pipelines shall be flushed and tested in such lengths or sections as agreed upon among the Owner, Engineer, and Contractor. Test pressures shall be as specified in Section 15390 – Schedules, and shall be measured at the lowest point of the pipe segment being tested. The Contractor shall give the Owner and Engineer reasonable notice of the time when he intends to test portions of the pipelines. The Engineer reserves the right, within reason, to request flushing and testing or any section or portion of a pipeline.

B. The Contractor shall provide water for all flushing and testing of liquid conveying pipelines. Raw water or non-potable water may be used for flushing and testing liquid pipelines not connected to the potable water system. Only potable water shall be used for flushing and testing the potable water system.

C. Air and gas piping shall be completely and thoroughly cleaned of all foreign matter, scale, and dirt prior to start-up of the air or gas system.

D. At the conclusion of the installation work, the Contractor shall thoroughly clean all new liquid conveying pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, etc., which may have entered the pipe during the construction period. If after this cleaning any obstructions remain, they shall be corrected by the Contractor, at his own expense, to the satisfaction of the Engineer. Liquid conveying pipelines shall be flushed at the rate of at least 2.5 feet per second for a duration suitable to the Engineer or shall be flushed by other methods approved by the Engineer.

E. Compressed/service air and gas piping shall be flushed by removing end caps from the distribution lines and operating one (1) compressor, in accordance with the manufacturer's instructions.

F. After flushing, all air piping shall be pressure and leak tested prior to coating and wrapping of welded joints. Immediately upon successful completion of the pressure and leak test, welded joints shall be thoroughly cleaned of all foreign matter, scale, rust, and discoloration and coated in accordance with the Specifications.

G. All process air piping shall be leak tested by applying a soap solution to each joint. Leak tests shall be conducted with one (1) blower in service at normal operating pressure.

H. During testing the piping shall show no leakage. Any leaks or defective piping disclosed by the leakage test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

I. All buried process air piping shall be pressurized to 25 psig and tested for leaks by applying a soap solution to each joint. The air supply shall be stopped and the pipe pressure monitored. System pressure shall not fall by more than 0.5% of the 25 psig test pressure over a one-hour test period. Should the system fail to hold the required pressure for one hour, the cause shall be determined and corrected and the test repeated until a successful test of the entire system is obtained.

J. Field leakage tests shall be performed for all submerged process air piping. The procedure shall consist of operating the system under clear nonpotable water for visual identification of all leaks. All field leakage tests shall be witnessed by the Engineer. All submerged piping shall be installed free of any leaks.

K. After flushing, all liquid conveying pipelines shall be hydrostatically tested at the test pressure specified in the appropriate Piping System Schedule in Section 15390 – Schedules. The procedure used for the hydrostatic test shall be in accordance with the requirements of AWWA C600. Each pipeline shall be filled with water for a period of no less than 24 hours and then subjected to the specified test pressure for 2 hours. During this test, exposed piping shall show no leakage. Allowable leakage in buried piping shall be in accordance with AWWA C600.

L. Any leaks or defective pipe disclosed by the hydrostatic test shall be repaired or replaced by the Contractor, at his own expense, and the test repeated until all such piping shows tight.

M. After flushing, all gas piping shall be leak tested in accordance with all local codes and regulations and in conformance with the recommendations or requirements of any National Institute or Association for the specific service application.

3.11 DISINFECTION

A. All pipe and fitting connected to and forming a part of a potable water supply shall be disinfected in accordance with the procedures described in AWWA C 651. Disinfection shall also be in accordance with the requirements of the Kentucky Division of Water (KDOW) and the Owner.

B. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of

chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or KDOW and/or the Owner until the minimum residual chlorine content of 10 ppm has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to placing the new sections of pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

3.12 PAINTING AND COLOR CODING SYSTEM

A. All exposed piping specified shall be color coded in accordance with the Owner's standard color designation system for pipe recognition and in accordance with Section 15030 – Piping and Equipment Identification Systems. In the absence of a standard color designation system, the Contractor will establish a standard color designation for each piping service category from color charts in compliance with Section 09900 – Painting.

B. All piping specified in this Section shall be painted in accordance with Section 09900 – Painting.

- END OF SECTION -

SECTION 15006

DUCTILE IRON PIPE

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. All ductile iron pipe and specials shall be marked with the manufacturer's name or trademark, size, weight, thickness class, the date of manufacture, and the word "Ductile". Manufacturer shall be American, Griffin Pipe or US Pipe and Foundry.

B. Ductile iron pipe (DIP) of the sizes shown or specified shall conform to ANSI A21.51 (AWWA C151), Grade 60-42-10 for ductile iron pipe centrifugally cast in metal molds or sand-lined molds. All ductile iron pipe shall conform to ANSI A21.50 (AWWA C150) for thickness design and shall be supplied in 18 or 20 foot nominal lengths or as required to meet the requirements of the Drawings. Fittings and specials shall be cast iron or ductile iron, conforming to the requirements of ANSI A21.10 (AWWA C110) or ANSI A21.53 (AWWA C153) and shall have a minimum rated working pressure of 250 psi.

C. Minimum Class 53 pipe shall be used for flanged spools.

D. Reference Section 15000, Basic Mechanical Requirements

## PART 2 -- PRODUCT

### 2.01 DUCTILE IRON PIPE AND FITTINGS

A. All pipe and fittings, with the exception of glass lined pipe and sleeves, shall be cement mortar lined. Linings shall conform to American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Ductile Iron Pipe and Fittings, ANSI A21.4 (AWWA C104) and shall be standard thickness. The mortar lining shall be protected with the bituminous seal coat. All buried DIP and fittings shall have a bituminous coating on the exterior surfaces in accordance with ANSI A21.51 (AWWA C151). All exposed DIP and fittings shall have a shop applied prime coat in accordance with Section 09900 - Painting.

B. Pipe and fittings shall be the class that equals or exceeds the pipe class as specified in Section 15390 - Schedules. Requirements for various types of joints are described in the following paragraphs. UNLESS OTHERWISE NOTED HEREIN OR ON THE DRAWINGS, ALL EXPOSED DUCTILE IRON PIPING SHALL HAVE FLANGED JOINTS.

C. Flanged joints and fittings shall have a minimum pressure rating of 250 psi with 125 lb. American Standard flanges. All flanges and fittings shall conform to the requirements of ANSI B16.1. Flanges shall be ductile iron and shall be of the threaded or screw on type. The face of the flanges shall be machined after installation of the flange to the pipe. No raised surface shall be allowed on flanges. Flanged pipe shall conform to the requirements of ANSI Specification A21.15, (AWWA C115). Pipe lengths shall be fabricated to meet the requirements of the Drawings.

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F. Gaskets shall be the "Ring Gasket" type, 1/8-inch minimum thickness, cloth inserted rubber, red rubber or neoprene and shall be suitable for the service intended. Gaskets for glass lined pipe shall be TORUSEAL flange gasket, or equal. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolts for flanged joints shall be a minimum ASTM A307; Grade B carbon steel and be in accordance with ANSI A21.10, (AWWA C110). The bolts shall have hexagonal heads and nuts, no washers shall be used.

G. Bell and spigot pipe shall be provided with push on, O-ring rubber gasket, compression type joints and shall conform to the requirements of ANSI A21.11 (AWWA C111). Fittings and specials shall be supplied with mechanical joints as specified for mechanical joint pipe. If required by installation conditions, pipe shall have cast-on lugs for adequately tying it together.

H. Mechanical joints and fittings shall conform to the requirements of ANSI A21.11, (AWWA C111). Joints shall be made employing a tapered rubber gasket forced into a tapered groove with a ductile iron follower ring. If required by installation conditions, pipe and fittings shall have cast-on lugs for adequately tying the pipe and fittings together. These shall be in conformance with standard practice and as outlined under the appropriate AWWA Specifications.

I. Bolts for mechanical joints shall be high strength corrosion resistant low-alloy steel tee-head bolts with hexagonal nuts.

J. Mechanical coupling joint pipe and fittings shall be split type, shouldered end. Coupling materials shall be malleable iron. Couplings shall have a minimum pressure rating and service equal to that of the connected piping. Gaskets shall be of rubber. Bolts and nuts shall be heat treated carbon steel track bolts and shall be plated. After installation, buried couplings shall receive two heavy coats of coal tar epoxy (min. 24 mil thickness) which is compatible with the finish of the couplings. Couplings shall be as manufactured by Victaulic Company of America Style 44, or equal.

K. Restrained joint pipe and fittings shall consist of bolted retainer rings, ductile iron locking segments held in place by rubber retainers, or ductile iron retaining rings that lock over the bell of the joint and are secured to prevent rotation, and factory welded retainer beads or rings on the spigot of the pipe. All components of the bolted or snap ring assemblies shall be constructed of corrosion-resistant, high strength, low-alloy steel. Restrained pipe and fittings shall be Flex-Ring or Lock-Ring type joints as manufactured by American Cast Iron Pipe Company, TR Flex as manufactured by US Pipe, Bolt-Lok or Snap-Lok as manufactured by Griffen Pipe Products, Super Lock as manufactured by Clow Water Systems Co., or equal.

L. The above systems for thrust restraint shall be used where restrained joint ductile iron pipe is specified. Thrust restraint and harnessing systems such as thrust blocks, threaded-rods, friction clamps, retainer glands, and other proprietary systems such as the Star Harnessing System, Mega Lug by EBAA Iron, etc. shall not be used unless specifically allowed by the Engineer in isolated applications such as connections to existing piping, or walls, etc. Where threaded-rods are allowed, the rods and tabs shall be designed for the specified restraint system design pressure, shall have lengths less than 10 feet between fittings, and shall be painted with two heavy coats of coal tar epoxy after installation.

M. Cast Iron Soil Pipe shall conform to the standards of the Cast Iron Soil Pipe Institute (CISPI) Specification HS-67, and also ANSI Specification A-112.5.2 for Hub & Spigot pipe or A.112.5.1 for Hub & Spigot pipe or A.112.5.1 for No-Hub Pipe. Pipe class shall be "Extra Heavy: (XH)".

- END OF SECTION -

SECTION 15008

PVC/CPVC PIPE AND HOSE

## PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pipe and fittings shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein, in Section 15390 - Schedules, or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. PVC pipe shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:

Socket Type (Schedule 40); ASTM D 2466
Socket Type (Schedule 80); ASTM D 2467

D. Provide flanged fittings of the same material as the specified pipe and material conforming to ANSI B16.5 at all valves and equipment with Teflon filled or natural rubber gaskets. Bolts shall be type 316 stainless steel for flanged joints. Flanges are not required at true (double) union valves.

E. Solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings.

F. C900-Class 200 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chloride (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 14 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket,

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compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM D1869 and ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 914 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 985 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 200, DR 14 shall be ductile iron, bolted mechanical joint.

G. C900-Class 150 shall be in sizes between 4 inches and 12 inches and shall meet the requirements of AWWA C900 "Poly Vinyl Chlorine (PVC) Pressure Pipe" and shall conform to all the requirements of ASTM D1784 and ASTM D2241. The pipe shall be a minimum of DR 18 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet (±1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed material shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2677. Elastomeric gaskets shall conform to the requirements of ASTM D1869 and ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 435 psi for all sizes when tested in accordance with D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 755 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. Fittings for C900-Class 150, DR 18 shall be ductile iron, bolted mechanical joint.

H. PVC pressure rated pipe (PR 160) shall be in sizes between 1 1/2 inches and 12 inches and shall conform to all the requirements of ASTM D1784 and ASTM D2241 and shall be a minimum of SDR 26 and shall be capable of withstanding the overburden pressures determined by the depth of burial in the field.

1. Pipe material shall be made from clean, virgin, NSF approved Class 12454-A PVC compound conforming to resin specification ASTM D1784. Standard laying lengths shall be 20-feet ("1 inch). Random lengths of not more than 15% of the total footage of each size may be shipped in lieu of the standard lengths. Reruns of reclaimed materials shall not be accepted.

2. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints conforming to the requirements of ASTM 2672. Elastomeric gaskets shall conform to the requirements of ASTM D1869 and ASTM F477.

3. Minimum pipe stiffness (F/dY) at 5% deflection shall be 135 psi for all sizes when tested in accordance with ASTM D2241.

4. The pipe shall be designed to pass a quick burst test pressure of 500 psi applied in 60 to 70 seconds when tested in accordance with ASTM D1599, as referenced in ASTM D2241.

5. The pipe shall be designed to pass for 1000 hours a sustained test pressure of 340 psi when tested in accordance with ASTM D1598, as referenced in ASTM D2241.

I. Fittings for PR 160, SDR 26 shall be PVC and designed for the pipe being supplied.

J. Acrylonitrile-butadiene-styrene (ABS) shall conform to the requirements of ASTM D 2661. Pipe and fittings shall have socket type couplings with solvent cement joints. Solvent cement shall conform to ASTM D 2235.

K. Type PSM polyvinyl chloride (PVC) pipe and fittings shall conform to the requirements of ASTM D 3034 with a maximum SDR of 35. Pipe and fittings shall have bell and spigot ends with O-ring rubber gasketed, compression type joints. Joints shall conform to the requirements of ASTM Specification D 3212. Reruns of reclaimed materials shall not be accepted. Unless indicated otherwise, PVC wall pipes shall be provided for all piping passing through exterior walls. Wall pipes shall have a water stop solvent-welded to the pipe. Each wall pipe shall be of the same class and type as the piping to which it is joined.

L. Perforated and closed drainage pipe and fittings shall be rigid PVC pipe, Schedule 40 unless otherwise shown or specified with solvent welded type joints, or approved equal. Pipe shall be slotted or have two rows of 1/4-inch diameter holes spaced 4-inches apart along the circumference of the pipe. Longitudinal spacing of holes shall be 5-inches maximum.

M. Solvent cement for socket type joints for sodium hypochlorite shall be Weld-On 724 as manufactured by IPS Corporation.

2.02 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS

A. CPVC shall be manufactured in accordance with ASTM D 1785, D 1784 and F 441, "normal impact" pipe, Schedule 40 or 80 as specified.

B. Fittings used with this pipe shall be socket type or flanged type as specified herein or indicated on the Drawings. Plastic piping shall be installed in full accordance with the manufacturer's recommendations for the specific installation. No field bending or distortion of the pipe will be permitted.

C. CPVC pipe shall be Type 4, Grade 1, Schedule 80, conforming to ASTM D 1784 and ASTM F 441. CPVC fittings shall be socket type conforming to ASTM F 439.

D. Solvent cement for socket type joints shall conform to ASTM F 493 for CPVC pipe and fittings.

E. Solvent cement for socket type joints for sodium hypochlorite shall be Weld-On 724 as manufactured by IPS Corporation.

2.03 REINFORCED PVC HOSE AND FITTINGS

A. Reinforced PVC hose shall be clear type, reinforced with polyester yarn. Hose shall be rated for a working pressure of 125 psi at 70°F. Hose shall be contiguous for a minimum of 300 feet and shall be contiguous between manholes with no splices. Hose shall meet NSF 61 standards for drinking water. Reinforced PVC hose shall be a manufactured product of Nexgen, or approved equal.

B. Joints shall be barb and clamp type as indicated in Section 15390, Schedules. Wetted materials shall be completely resistant to corrosion by the specified chemicals.

- END OF SECTION -

SECTION 15009

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. The pipe shall be manufactured from Type III, Category 5, Class C, Grade P34 polyethylene resin in accordance with ASTM D-1248 and shall be SDR11, minimum. The pipe shall be manufactured in accordance with ASTM F-714 and shall conform to cell classification PE 345434C for PE 3408 under ASTM D-3350. The pipe material shall conform to the following cell classification requirements:

| Property | Value | ASTM Test Procedure Designation |
|---|---|---|
| Density | 0.955 gm/cm$^3$ | D-1505 |
| Melt Flow | 0.1 gm/10 mil | D-1238 |
| Flexural Modular | 133,000 psi | D-790 |
| Tensile Strength | 3500 psi | D-638 |
| ESCR | $F_o$>5000 | D-1693 |
| Hydraulic Design Basis | 1600 psi | D-2837 |
| UV Stabilizer | 2-3% carbon black | D-160 |

B. The HDPE pipe shall have an elastic modulus of 100,000 psi as tested under ASTM D-638. The brittleness temperature shall be not greater than –180°F nor the Vicat Softening Temperature greater than 255°F as tested under ASTM D-746 and D-1525, respectively. The coefficient of thermal expansion shall be 8 x $10^{-5}$ inch/°F as tested under ASTM D-606. The Shore Hardness D shall be greater than 61 as tested under ASTM D-2240. The Hydrostatic Design Stress Basis (HDB) shall be 1,600 psi at 23°C and 800 psi at 60°C as tested under ASTM D-2837. The pipe shall contain no recycled materials or compounds.

C. HDPE pipe shall be marked either continuously or on intervals not to exceed five (5) feet by indirect printing with the following information:

1. Name and/or trademark of the manufacturer.

2. Nominal pipe size.

3. Dimension ratio.

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4. The letters PE followed by the polyethylene grade per ASTM D-1248, followed by the Hydrostatic Design basis in 100's of psi.

5. Manufacturing Standard Reference.

6. Production Code from which time and date of manufacture can be determined.

D. HDPE fittings shall be manufactured to the requirements of ASTM D-3261 and this Specification. Fabricated fittings shall be manufactured from pipe of at least one SDR heavier pipe than the system piping, and shall be pressure rated to match the system piping. The butt fusion outlets of fabricated fittings shall be machined to the same SDR as the system piping to which they are to be fused. The manufacturer shall subject samples of each production lot of molded fittings to x-ray inspection for voids. Voids shall not be permitted, should voids be found in the samples, the entire production lot shall be x-ray inspected. If additional voids are found, the production lot shall be rejected. The x-ray testing shall be conducted by an independent laboratory and certified test reports made available to the Engineer upon request. Initial sampling shall be limited to not less than 5% of the production lot.

E. HDPE pipes and fittings shall be joined one to another by thermal butt fusion, saddle fusion, or socket fusion in accordance with procedures recommended by the pipe manufacturer and as outlined in ASTM D-2657. The manufacturer shall provide fusion training services to the Contractor upon request.

F. Butt fusion joining of unlike SDR's shall not be permitted. Transition from one SDR to another shall be accomplished by the use of mechanical couplings or a transition nipple, which is a short length of the heavier SDR pipe with one end machined to the lighter SDR.

G. Mechanical connections of polyethylene pipe to systems or fittings of other materials, or to unlike SDR, shall be by means of flanged connections (flange adapters and back-up rings rated for the same pressure service as the system piping), or mechanical compression couplings designed for jointing HDPE to HDPE or HDPE to another piping material.

H. Flanged joints shall use compatible bolts in accordance with the American Standard Gaskets of reinforced rubber or asbestos-rubber shall be required when joining to non-HDPE materials. Flanged HDPE joints shall be gasketed at all service pressures.

I. Bolts in flanged joints shall be evenly torqued in a crossing pattern. Bolts shall be re-torqued after one hour or more has passed. HDPE pipe adjacent to flanged joints and the joints themselves shall be rigidly supported for a distance of one (1) foot or one pipe diameter, whichever is greater, beyond the flange assembly.

J. When mechanical compression couplings are used HDPE pipes shall be reinforced by a stiffener in the pipe bore. Stiffeners shall be properly sized from the size and SDR of pipe being joined. Mechanical couplings shall be installed in accordance with the manufacturer's recommended procedure.

K. Tests for compliance with this Specification shall be made as specified herein and in accordance with the applicable ASTM Specification. A certificate of compliance and a report of each test shall be furnished by the manufacturer for all material furnished under

this Specification. HDPE pipe and fittings shall be rejected for failure to meet the requirements of this Specification.

- END OF SECTION -

# SECTION 15010

# COPPER PIPE

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

### 2.01 TYPE L COPPER PIPE AND FITTINGS

A. Type L copper piping shall be seamless, hard drawn and shall conform to ASTM B 88. Solder fittings shall be wrought copper conforming to ANSI B.16.22 or cast brass conforming to ANSI B.16.18 95/5. All exposed copper pipe and fittings shall be Type L.

### 2.02 TYPE K COPPER PIPE AND FITTINGS

A. Type K copper piping shall be seamless, soft temper and shall conform to ASTM B 88. Fittings used with this pipe shall be flare or compression type fittings as manufactured by Swagelok, or equal, and shall conform to ANSI B16.26. All buried copper pipe and fittings shall be Type K.

### 2.03 SOLDER

A. Solder shall consist of 95 percent tin and 5 percent antimony. Silver solder shall consist of 15 percent silver, 80 percent copper, and 5 percent phosphorous in accordance with ASTM B260-62T. Soldering shall be in conformance with Section 3 of the C.A.B.R.A. Copper Tube Handbook.

### 2.04 SOFT COPPER TUBING

A. Soft copper tubing in all sizes, shall conform to the appropriate ASTM Specifications; and fittings used with this tubing shall be compression or flare type, as manufactured by Swagelock, or equal.

- END OF SECTION -

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# SECTION 15012

# STEEL PIPE

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Steel pipe and fittings shall conform to AWWA C200 for nominal pipe sizes 6-inches and larger. Steel pipe shall be new and shall meet or exceed the manufacturer and material requirements of ASTM A53, Grade B or ASTM A139, Grade B.

B. The AWWA Specifications referenced in this section are supplemented as follows:

1. An affidavit of compliance is required from the pipe manufacturer.

2. The steel manufacturer's certification that the material meets the ASTM Specification will be accepted in lieu of tests on specimens taken from the fabricated pipe.

3. The fabricator may purchase steel plates on the chemical basis only, and shall furnish to the Owner certified test reports.

4. Joints shall be flanged unless otherwise indicated on the Drawings.

C. All parts of the materials furnished shall be amply designed, manufactured and constructed for the maximum stresses occurring during fabrication and erection. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which they will be subjected and shall conform to all applicable sections of these Specifications. Manufacturer's designs shall accommodate all the requirements of these Specifications.

D. The Contractor shall be responsible for the structural design of the steel pipe. The Contractor shall submit certification that the steel pipe has been designed to resist all loads implied and reasonably anticipated.

E. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

### 2.01 EXTERIOR STEEL PIPE AND FITTINGS (PROCESS AIR AND WATER)

A. Exterior steel pipe shall be fabricated by either the spiral weld or single longitudinal seam method and shall be rated for at least 25 psig and 250°F. Steel pipe shall be fabricated by either the spiral weld or single longitudinal seam method with a minimum yield strength of 35,000 psi. Design stress in the pipe wall at the design pressure shall not exceed 50 percent of the minimum yield strength of the steel.

B. Fittings shall be fabricated from the pipe specified and shall conform to AWWA C208, Table 1 (Figure 1). Fittings provided for the purpose of transition to other types of piping

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shall be in accordance with the applicable portions of AWWA C207 and AWWA C208, unless otherwise shown on the Drawings.

C. Flanges shall be AWWA C207, Standard hub type, slip-on welding flanges, Class B, unless otherwise required for connection to equipment. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolt for flanged joints shall be a minimum ASTM A307; Grade B carbon steel and be in accordance with ANSI A21.10, (AWWA C110). The bolts shall have hexagonal heads and nuts, no washers shall be used. All gaskets shall be the "Ring-Gasket type, 1/8-inch minimum thickness of material suitable for 250 F continuous service at 25 psig.

D. Welded field connections shall be of the single "V" butt joint type in accordance with AWWA C206. Welded connections shall not be permitted where such connections would interfere with the removal of valves or equipment or create sections of pipe too large for removal from structures. All field welds shall be radiographically inspected when field welding is permitted.

E. The minimum wall thickness for exterior steel pipe shall be .250-inch for pipe up to 30-inch diameter and .375-inch for larger than 30-inch diameter.

F. Interior and exterior coatings for exterior steel pipe and fittings shall be as specified in this Section, paragraph 2.03.

2.02 INTERIOR STEEL PIPE AND FITTINGS (PROCESS AIR AND WATER)

A. Steel pipe shall be fabricated by either the spiral weld or single longitudinal seam method with a minimum yield strength of 35,000 psi. Design stress in the pipe wall at the design pressure shall not exceed 50 percent of the minimum yield strength of the steel.

B. Steel pipe shall be manufactured to the nominal pipe sizes listed and shall have the following minimum wall thicknesses:

| Nominal Pipe Size | Minimum Sheet or Plate Thickness, inches | | |
|---|---|---|---|
| | Process Air | 100 psi Design Pressure | 300 psi Design Pressure |
| 6 or less | 0.125 | 0.125 | 0.125 |
| 8-14 | 0.134 | 0.134 | 0.134 |
| 16 | 0.134 | 0.134 | 0.188 |
| 18 | 0.188 | 0.188 | 0.188 |
| 20-24 | 0.250 | 0.250 | 0.250 |
| 30 | 0.250 | 0.250 | 0.281 |
| 36 | 0.250 | 0.250 | 0.344 |
| 42 | 0.250 | 0.250 | 0.375 |
| 48-54 | 0.250 | 0.250 | 0.500 |
| 60-66 | 0.312 | 0.312 | 0.625 |
| 72-84 | 0.375 | 0.375 | 0.750 |
| 90 | 0.375 | 0.375 | 0.8125 |

C. Fittings shall be fabricated from the pipe specified and shall conform to AWWA C208, Table 1 (Figure 1). Fittings provided for the purpose of transition to other types of piping shall be in accordance with the applicable portions of AWWA C207 and AWWA C208, unless otherwise shown on the Drawings.

D. Flanges shall be AWWA C207, standard hub type slip-on welding flanges, in accordance with the following table, unless otherwise required for connection to equipment:

| Design Pressure | Flange Class |
|---|---|
| 86 psi or less (All sizes) | B |
| 87 - 149 psi (4 - 12 inch) | D |
| 87 - 175 psi (14 inch and larger) | D |
| 150 - 275 psi | E |
| 276 - 300 psi | F |

E. All gaskets shall be the "Ring-Gasket" type, 1/8-inch minimum thickness. Bolts shall be of the size and length called for and in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolts for flanged joints shall be a minimum ASTM A307; Grade B, hot-dip galvanized carbon steel in accordance with ANSI A21.10 (AWWA C1110) unless otherwise specified. The bolts shall have hexagonal heads and nuts, no washers shall be used.

F. The piping layout shown on the Drawings is based upon standard fittings available in ductile iron pipe in the case of water piping and typical fittings available in steel piping for process air. In some instances, flange joints shown may not be required for steel pipe. Welded joints may be substituted for flange joints subject to approval by the Engineer. Welded joints will not be acceptable where such joints would interfere with the removal of valves or equipment or create sections of piping too large for removal from structures as determined by the Engineer.

G. Harnessed flexible couplings may also be used in lieu of flanges at locations approved by the Engineer. Lugs shall be welded to the pipe in accordance with the requirements of AWWA Manual M11 for Steel pipe where required for harnessing of flexible couplings.

H. Welded field connections shall be of the single "V" butt joint type in accordance with AWWA C206. Welded connections shall not be permitted where such connections would interfere with the removal of valves or equipment or create sections of pipe too large for removal from structures. All field welds shall be radiographically inspected when field welding is permitted.

I. Interior and exterior coatings for interior steel pipe and fittings shall be as specified in this Section, paragraph 2.03.

2.03 STEEL PIPE COATINGS

A. Exterior and interior coatings for steel pipe and fittings used for process air or water piping shall be as follows:

| Type of Service | Exterior Coating | Interior Coating |
|---|---|---|
| Water | Shop Prime per Section 09900 – Painting | Cement Mortar AWWA C 205 |

B. Exterior and interior coatings for steel pipe and fittings used for process air piping shall be as follows:

1. The steel pipe coatings and lining specified herein apply to all exposed and buried steel process air piping. Steel pipe shall have an interior lining and exterior coating for exposed or buried service as specified. Painting shall be in accordance with Section 09900 - Painting. Inspection of surface preparation and coating application is required in accordance with Section 09900 -Painting.

2. The interior of all steel pipe for process air service shall receive 3 mils (dry) of inorganic zinc primer service rated for 250°F (dry) and 100°F (wet) continuous which shall be Carbo Zinc 11 as manufactured by Carboline or equal. After the lining has cured, it shall be thoroughly washed with high pressure water to remove all detachable particles.

3. Areas of pipe to be welded shall receive 1 mil (dry) of weldable inorganic zinc primer such as Carbo Weld 11, as manufactured by Carboline, or equal.

4. Interior steel pipe and fittings:

   a. The exterior of all interior steel pipe and fittings shall receive the same prime coat as that specified for the interior except for areas of pipe to be field welded. After welding and pressure and leakage testing are completed, welded joints shall be thoroughly cleaned of all foreign matter and any scale or rust and primed as specified for the pipe. Finish coat and wrap shall be applied to each joint as specified for the pipe for continuous coating and wrapping of all steel piping.

   b. Final touch up of inorganic zinc primer shall be with a modified aluminum epoxy mastic such as Carbomastic 15 as manufactured by Carboline, or equal.

   c. Shop coatings and field touch-ups shall be electrically inspected by the use of a holiday detector in accordance with AWWA C209 and Division 09900 - Painting.

5. Exterior steel pipe and fittings:

   The exterior of all exposed steel pipe and fittings shall receive the same prime coat as that specified for interior steel pipe and fittings.

   a. The exterior of all buried steel pipe and fittings shall receive a prime coat per the exterior tape system manufacturer's recommendations, except for areas of pipe to be field welded.

   b. The exterior of buried steel pipe shall receive, over the prime coat, a multi-layered, cold-applied tape wrap system which shall be shop applied

and consist of a rubber and synthetic resin primer, one (20 mils) layer of inner wrapping and two (30 mils each) layer of outer wrap for a total system build in excess of 80 mils. The cold applied type wrap shall operate satisfactorily at a temperature of 200°F. The wrap shall be applied in accordance with AWWA C214 and as specified herein. Windings shall be spiral wrapped with at least 1" of overlap. All fittings shall be wrapped in accordance with AWWA C209. Successive layers shall be applied such that windings are staggered and overlay the midpoints of previous tape widths. Polyethylene backed coatings shall be protected from sunlight at all times. The wrapping shall terminate 6" from field weld sites. The tape wrap system shall be the YG III system as manufactured by the Polyken Division of Kendall Co., Boston MA, or equal.

c. The exterior of exposed exterior steel pipe and fittings shall receive, over the inorganic zinc prime coat, 3 mils of modified acrylic latex service rated for 300°F (continuous) which shall be Carboline 3359 as manufactured by Carboline or equal, and 1-1/2 mil top coat of modified acrylic, service rated for 300°F (continuous), which shall be Carboline 4685 as manufactured by Carboline, or equal.

d. After welding and pressure and leakage testing are completed, welded joints shall be thoroughly cleaned of all foreign matter and any scale or rust and primed as specified for the pipe. Finish coat and wrap shall be applied to each joint as specified for the pipe for continuous coating and wrapping of all steel piping.

e. Final touch up of inorganic zinc primer shall be with a modified aluminum epoxy mastic such as Carbomastic 15 as manufactured by Carboline, or equal.

f. Shop coatings and field touch-ups shall be electrically inspected by the use of a holiday detector in accordance with AWWA C209 and Section 09900 - Painting.

2.04 STAINLESS STEEL PIPE AND FITTINGS (PROCESS AIR AND WATER)

A. Stainless steel piping for air piping of nominal sizes ranging from three (3) inches to sixty (60) inches shall be manufactured from ASTM A240 annealed and pickled sheets and plates and fabricated in accordance with ASTM A778 in Type 304L stainless steel. Only stainless steel pipe shall be provided; tubing shall not be allowed. Stainless steel pipe, at a minimum, shall be service rated for 250°F at 25 psig. Stainless steel pipe shall be as manufactured by Douglas Brothers, Felker Bros. Corp., or equal.

B. The following information shall be provided:

1. An affidavit of compliance is required from the pipe manufacturers.

2. The steel manufacturer's certification that the material meets the ASTM specification will be accepted in lieu of tests on specimens taken from fabricated pipe.

3. The fabricator may purchase steel plates on the chemical basis only, and shall furnish to the Owner certified test reports.

4. Only seamless or one (1) longitudinal seam shall be permitted unless otherwise required for fabrication of large diameter pipe in accordance with ASTM A774.

5. Joints in piping 3-inches in diameter or larger shall be butt welded or flanged, unless otherwise shown on the Drawings. Joints in piping less than 3-inch diameter shall be threaded, unless otherwise shown on the Drawings.

C. Fittings shall be fabricated from the pipe specified and shall conform to ASTM A774, unless otherwise shown on the Drawings or required for proper installation.

D. Flanges where shown on the Drawings shall be a lap joint flange assembly consisting of a 304L S.S. slip-on rolled angle ring with a galvanized ductile iron follower flange conforming to ASTM A536, and shall conform dimensionally to ANSI B16.1, Class 125. Bolts shall be the size and length called for an in accordance with the "American Standard" and comply with the requirements of the ANSI/AWWA Standards. The bolts for flanged joints shall be a minimum ASTM A307; Grade B, hot-dip galvanized carbon steel in accordance with ASTM A123 and A153, and be in accordance with ANSI A21.10, (AWWA C110) unless otherwise specified. The bolts shall have hexagonal heads and nuts, no washers shall be used.

E. The angle leg shall not interfere with the flange bolt holes. The back-up flanges shall be supplied with the following nominal thicknesses.

| Nom. Pipe Size (in.) | Flange Thickness (in.) |
|---|---|
| 2-1/2 - 3 | ½ |
| 4 | 9/16 |
| 6 - 10 | 5/8 |
| 12 - 16 | ¾ |
| 18 - 20 | 7/8 |
| 24 - 30 | 1 |
| 36 | 1-1/8 |
| 42 | 1-1/4 |
| 48 | 1-3/8 |
| 54 | 1-3/8 |
| 60 | 1-1/2 |

F. Gaskets for water piping shall be "Ring Gasket" type, 1/8-inch minimum thickness, cloth inserted rubber, red rubber or neoprene and shall be suited for the service intended. For process air, all gaskets shall be 1/8-inch minimum thickness and shall be of a material suitable for 250°F continuous service at 25 psig. Dielectric gasket material service rated for 225°F continuous service at 25 psig shall be provided at all transitions to material other than mild steel.

G. Welding practices for joints shall conform to those specified for the manufacture of the pipe and fittings in ASTM A774 and A778, and the specifications contained herein. All welds shall be free from burrs, snags or rough projections.

H. Welding shall be performed by AWS certified welders in conformance with standard procedures. Piping with wall thickness up to 11 gauge (0.125") shall be welded with the TIG

(GTAW) process. Heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping or fittings. Concavity, undercut, cracks or crevices shall not be allowed. Butt-welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter and projections shall be removed by grinding. Angle face rings shall be continuously welded on both sides to the pipe or fitting. Welds on gasket surfaces shall be ground smooth.

I. After welding, all welded joints shall be treated with a pickling solution, brushed with stainless wire brushes and rinsed clean.

J. All fittings shall be welded with 304L filler metal. All elbows through 24 inch size shall be long radius, die formed and shall be automatically butt welded in accordance with ASTM A774 of the same material and thickness as the pipe, using gas tungsten-arc procedures with inert gas backing. Tees, crosses, true Y's and laterals shall be shop fabricated. All short radius, special radius, and reducing elbows and long radius elbows greater than 24 inch shall be mitered construction with at least (5) miter sections for 90 degree bends, (3) mitered sections for 45 and 60 degree bends, and (2) mitered sections for 30 degree and smaller bends. All reducers shall be straight tapered, cone type. Longitudinal welds on all fittings, except elbows, shall be accomplished by the same procedures as listed for pipe. Weld seams shall have full penetration and be free of oxidation, crevices, pits, cracks and protrusions. Fitting dimensions shall be in accordance with ANSI B16.9, and shall be terminated and dimensioned as indicated on the Drawings.

K. Pipe spools shall be manually welded with 304L filler metal, using gas tungsten-arc procedures with internal gas purge where internal weld seams are not accessible. Where they are accessible, seams shall be welded both inside and outside, using manual shielded metal-arc procedures. Weld seams shall have full penetration and be free of oxidation, crevices, pits, cracks and protrusions.

L. All pipe, fittings and spools shall be completely pickled and passivated by immersion in a nitric-hydrofluoric bath at the proper temperature and length of time to insure removal of all free iron, weld scale and other impurities and to insure the establishment of a passive surface. A clean water rinse shall follow the acid pickle.

M. The field testing procedure for process air piping shall use air pressure only. Hydrostatic testing shall be utilized on all other stainless steel piping.

N. The inspection of all welds shall be required. This shall be a visual inspection for crevices, pits, cracks, protrusions and oxidation deposits. Presence of any of these items found in the weld seams shall be considered as grounds for rejection of the joint.

O. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks shall be located on the spools at opposite ends and 180 degrees apart.

P. The piping supplier during manufacturing, fabrication and handling stages, and the Contractor during handling and installation stages, shall use extreme care to avoid the

contact of any ferrous materials with the stainless steel piping. Only manufacturer recommended saws, drills, files, wire brushes, etc. shall be used for stainless steel piping. Pipe storage and fabrication racks shall be non-ferrous or stainless steel or rubber lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

Q. FIELD WELDING OF STAINLESS STEEL WILL NOT BE PERMITTED.

R. Pipe shall be manufactured to nominal pipe sizes as listed in ANSI B36.19, Table 2, and shall have the following minimum wall thicknesses:

| Nominal Pipe Size | Schedule/Gauge/Plate |
|---|---|
| 8-inch diameter and smaller | Schedule 5S (.083 inches) |
| 10-inch and 12-inch diameters | 12 gauge (.109 inches) |
| 14-inch thru 18-inch diameters | 11 gauge (.125 inches) |
| 20-inch diameter | 10 gauge (.140 inches) |
| 24-inch thru 36-inch diameters | 3/16-inch (.187 inches) |
| 42-inch and 48-inch diameters | 1/4-inch (.250 inches) |
| 54-inch and 60-inch diameters | 5/16-inch (.312 inches) |

S. All parts of the materials furnished shall be amply designed, manufactured and constructed for the maximum stresses occurring during fabrication and erection. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which they will be subjected and shall conform to all applicable sections of these Specifications. Manufacturer's designs shall accommodate all the requirements of these Specifications.

T. The Contractor shall be responsible for the structural design of the stainless steel pipe. The Contractor shall submit certification that the stainless steel pipe has been designed to resist all loads implied and reasonably anticipated.

2.05 STEEL PIPE AND FITTINGS FOR NATURAL GAS, PROPANE GAS AND COMPRESSED SERVICE AIR

A. Steel pipe and fittings for natural gas, propane gas and compressed service air shall conform to ASTM A120, black, seamless, Schedule 40 or 80 as indicated in the Interior Piping System Schedule. Unless otherwise shown or required, all pipe and fittings shall be threaded. Fittings shall conform to ANSI B16.3, 300 pound class and shall be of the black malleable iron screw type. All threaded joints shall conform to ANSI B2.1 with tapered threads at 3/4 inches per foot. Joints shall be made tight with an oil and graphite paste or teflon thread tape applied to the male threads only. All pipe 1-1/2-inches and smaller shall be reamed to remove scale and dirt.

2.06 CORRUGATED METAL PIPE (CMP)

A. Corrugated Metal Pipe (CMP) and fittings shall be of the sizes shown or specified and shall conform to every aspect of AASHTO M-36, latest revision.

B. Corrugated metal pipe shall be fabricated from galvanized steel sheets. Corrugation profile shall be 2-2/3-inch crest to crest and 1/2-inch crest to valley, and sheet thickness shall be 16 gage/.064-inch minimum.

C. Pipe sections shall be helically corrugated with each pipe end rerolled to obtain no less than two (2) annular corrugations.

D. Bands for connecting pipe shall be fabricated from galvanized steel. Bands shall be flat with a continuous corrugation on each end to index the second pipe corrugation. Bands shall be 16 gage/.064-inch thick minimum, 10-1/2-inches wide minimum, and shall be drawn together by no less than two (2) 1/2-inch diameter galvanized steel bolts with nuts.

E. All CMP utilized for permanent installation shall have gasketed joints.

2.07 STEEL CASING PIPE

A. Casing pipe shall be smooth wall or spiral welded steel pipe with a minimum yield strength of 35,000 psi before cold forming. The minimum pipe size and wall thickness shall be as indicated in the table below. All joints shall be welded. The casing pipe shall be new and shall conform to ASTM A 139, Grade B, ASTM A53, Grade B, and AWWA C200-75. The carrier pipe shall be as specified.

| Carrier Pipe Size (Nom.) | Casing Pipe Size (Min. O.D.) | Casing Pipe Wall Thickness (min) |
|---|---|---|
| 36” | 48” | 5/8” |
| 30” | 42” | 5/8” |
| 24” | 36” | 1/2” |

2.08 MISCELLANEOUS STEEL PIPE AND FITTINGS

A. Other steel pipe and fittings not specified elsewhere shall conform to ASTM A120, black or galvanized, as directed by the Engineer, seamless, Schedule 40 or 80 as indicated in the appropriate Piping System Schedule in Section 15390, Schedules.

B. Unless otherwise shown or required, all piping and fitting shall be threaded. Fittings shall conform to ANSI B16.3, 300 pound class and shall be of the black malleable iron screw type. All threaded joints shall be made tight with an oil and graphite paste or teflon thread tape applied to the male threads only. All pipe 1-1/2 inches and smaller shall be reamed to removed scale and dirt. Pipe to be galvanized shall have a deep galvanized coating applied in full accordance with ASTM A123.

- END OF SECTION -

SECTION 15020

PIPE SUPPORTS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Reference Section 05050, Metal Fastening.

B. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

### 2.01 HANGERS AND SUPPORTS

A. All piping shall be adequately supported and braced by means of adequate hangers, concrete piers, pipe supports, brackets, or otherwise as may be required by the location. Generally, concrete supports shall be used where pipe centerline is less than 3 feet above floor, and hangers above 6 feet unless specified or shown otherwise. Supports shall be not more than 10 feet on center for steel and cast iron, 5 feet on center for plastic unless otherwise shown on the Drawings or required by the specific manufacturer. All necessary inserts or appurtenances shall be furnished and installed in the concrete or structures for adequately securing hangers and supports to the structure.

B. Hangers and supports shall conform to the following requirements:

1. All hangers and supports shall be capable of adjustment after installation. Types of hangers and supports shall be kept to a minimum.

2. Hanger rods shall be straight and vertical. Chain, wire, strap, or perforated bar hangers shall not be used. Hangers shall not be suspended from other piping.

3. Vertical piping shall be supported at each floor and between floors by stays or braces to prevent rattling and vibration.

4. Supports and hangers for plastic piping shall include wide saddles or bands as recommended by the manufacturer and approved by the Engineer to distribute load and thus avoid localized deformation of the pipe.

5. Hanger and supports shall prevent contact between dissimilar metals by use of copper plated, rubber, vinyl coated or stainless steel hangers.

6. Ferrous pipes to be painted shall be painted in accordance with Section 09900 - Painting. Ferrous pipes that do not require painting shall be supported by galvanized hangers and supports.

7. Copper piping shall be supported by plastic coated or copper plated steel hangers and supports.

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8. Plastic piping shall be supported by plastic coated steel hangers and supports.

9. Hangers and supports shall provide for thermal expansion throughout the full operating temperature range.

10. Expansion type anchors used for pipe hangers and supports shall be Type 304 stainless steel.

C. All metallic hangers and supports shall be standard make by Anvil International, Inc., "Witch" by Carpenter & Paterson, Ltd., B-Line Systems, Inc., or equal; and data on the types and sizes to be used shall be furnished to the Engineer for approval. Metallic support system brackets, rods, support clips, clevis hangers, hardware, etc. shall be cast iron or welded steel construction.

D. Non-metallic support system shall be a heavy duty channel framing system. Channel frames shall be manufactured by the pultrusion process using corrosion grade polyester or vinylester resins. All fiberglass construction shall include suitable ultraviolet inhibitors for UV exposure and shall have a flame spread rating of 25 or less per ASTM E84. Piping accessories, pipe clamps, clevis hangers, support posts, support racks, fasteners, etc., shall be constructed of vinylester or polyurethane resin. Non-metallic support systems shall be standard make Aickinstrut by Aickinstrut, Inc., Unistrut Fiberglass by Unistrut, Inc., Enduro Fiberglass Systems, or equal. The Subcontractor shall submit data on the types and sizes of approval. Unless otherwise shown or specified the Subcontractor shall provide support spacings in the conformance with the pipe and support system manufacturer's requirements.

2.02 PROCESS AIR PIPE SUPPORTS

A. Process air piping shall be supported by slide bearings as manufactured by Fluorocarbon Company, Anaheim, California, Anvil International, Inc., Portsmouth, New Hampshire, or equal.

B. The slide bearing material shall be 3/32 inch thick, 25 percent glass-fiber reinforced structural grade teflon. The bearing material shall withstand at least 1000 psi (compression) at 210°F with a coefficient of friction between .05 and.08. The performance of bearing and bonding materials shall be unaffected by continual immersion in wastewater containing domestic and industrial waste at a temperature of 210°F.

C. Non-submerged slide bearing type supports shall be provided with a bearing material covering a 120° arc centered at the bottom of the pipe. The teflon shall be at least 4 inches wide at the underside of the pipe and 8 inches wide at the top of the support. The teflon material shall be hot press bonded to 10 ga. stainless steel plates for welding to the bottom of the pipe and securing to the top of the support.

D. Submerged slide bearing type supports shall be provided with teflon bonded to the underside of the hold down strap and the top of the pipe such that the sliding surface is formed between two sheets of teflon. Each surface shall cover a 120° arc centered at the top of the pipe. On the underside of the strap the teflon bearing shall be hot press bonded directly to the stainless steel strap or to a 10 ga. stainless steel plate for welding to the strap. At the top of the pipe, the teflon shall be bonded to a 10 ga. stainless steel plate for welding to the pipe.

E. Pipe straps shall not tightly bind the pipe but shall provide 3/32 inch clearance over the top 180° of the pipe surface.

F. Wall bracket supports shall be used where shown for pipe to be installed adjacent to a wall. Where it is not feasible to install hanger supports, adjustable pipe saddle supports may be used with the permission of the Engineer. Concrete pier supports shall be spaced at a maximum distance of 10 feet and shall be at least one (1) foot square unless otherwise shown on the Drawings.

G. Small diameter piping (6-inches in diameter or less) shall not be strapped or otherwise secured directly to walls. Suitable wall offset brackets of an approved type shall be used. Anchors shall not be attached using percussion fasteners.

H. Sliding surfaces shall be protected from accumulation of dirt, grit, or other foreign matter.

I. Slide bearings shall be capable of adequately supporting the design loads and shall be attached to pipe and supports as specified and recommended by the manufacturer.

J. The slide bearings shall be installed in the locations shown or indicated on the Drawings, at required elevations, true to orientation and level, assuring that the correct half of each bearing is in its proper position. The Subcontractor shall store the bearings to protect them from mechanical damage prior to installation, and shall protect the same during and after installation from contamination and damage due to placing of concrete and other materials. The Subcontractor shall clean the operating surfaces of bearings thoroughly before final assembly.

K. The Subcontractor shall note that all pipe support locations are not shown on the Drawings, and shall follow the Specifications herein in locating supports. Where deviations and modifications are required, they shall be made only with the permission of the Engineer. A detailed layout of pipe supports and hangers shall be submitted for approval.

- END OF SECTION -

# SECTION 15030

# PIPING AND EQUIPMENT IDENTIFICATION SYSTEMS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all components of the system for identification of piping and equipment as specified hereinafter. The system shall include the application of color coding to all new and altered plant piping. The Contractor shall paint the equipment and piping of all Contracts in the colors herein specified, and in accordance with the requirements of Section 09900, Painting.

B. In addition to the legends specified herein the Engineer may order the Contractor to furnish and install additional identification legends and arrows at no additional cost to the Owner. Such additional signs may be requested near completion of the work and shall be limited to no more than five (5) signs for each type specified herein. The legends and color combinations for additional signs shall conform to the requirements specified herein.

C. The Contractor shall submit a schedule of the colors and designations proposed in accordance with Section 01300, Submittals, and this Section. A minimum of four (4) color charts with cross-references to the colors listed herein shall be included with the Submittal.

D. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

### 2.01 PIPING BAND

A. All new and altered piping shall receive identification bands. Such bands shall be 6-inches wide, neatly made by masking, and spaced at intervals of 30-inches on centers regardless of the diameter of the pipe being painted. The Contractor may use approved precut and prefinished metal bands on piping, in lieu of the masked and painted bands, where approved by the Engineer.

### 2.02 PIPING IDENTIFICATION LEGEND

A. The Contractor shall apply identification legends to all types and sections of piping as shown on the Drawings or as designated by the Engineer. Such legends shall be in the form of plain block lettering giving the name of the pipe content in full or abbreviated form, and showing the direction of flow by arrows. All lettering and arrows shall be of the plastic snap-on type, Seton nameplate "setmarks", or equal, or they shall be formed by stenciling in an approved manner using white or black as directed and shall have an overall height in inches in accordance with the following table:

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| Diameter of Pipe or Pipe Covering | Height of Lettering |
|---|---|
| 3/4 to 1-1/4 inches | 1/2-inches |
| 1-1/2 to 2-inches | 3/4-inches |
| 2-1/2 to 6-inches | 1-1/4-inches |
| 8 to 10-inches | 2-1/2-inches |
| Over 10-inches | 3-1/2-inches |

B. Identification lettering shall be located midway between color coding bands where possible. Identification lettering and arrows shall be placed as directed by the Engineer, but shall generally be located each fifteen (15) feet in pipe length, and shall be properly inclined to the pipe axis to facilitate easy reading. In the event lettering and arrow identifications are required for piping less than 3/4-inch in diameter, the Contractor shall furnish and attach approved color coded tags where instructed.

C. The colors referenced in the legend are as manufactured by KOP-COAT. They are used for convenience only.

D. Piping and Equipment Identification

| Service | Legend | Base |
|---|---|---|
| Raw Water | Raw Water | Olive Green |
| Aerated Raw Water | Aerated Water | Aqua |
| Finished Water | Finished Water | Dark Blue |
| Filter-to-Waste | Filter-to-Waste | Green |
| Backwash Supply | Backwash | Light Gray |
| Backwash Waste | BW Waste | Light Brown |
| Recycle | Recycle | Olive Green |
| Solids | Solids | Dark Brown |
| Potable Water | Potable Water | Dark Blue |
| Non-potable Water | Non-potable Water | Dark Blue with Yellow Band |
| Overflow/Drain | Overflow/Drain | Light Gray |
| Compressed and Process Air | Air | Dark Green |
| Sodium Permanganate | Sodium Permanganate | Violet |
| Sodium Hypochlorite | Sodium Hypochlorite | Yellow |
| Filter Aid Polymer | Filter Aid Polymer | Orange with Green Band |
| Fluoride | Fluoride | Light Blue with Red Band |
| Phosphoric Acid | Phosphoric Acid | Light Green with Red Band |

2.03 VALVE IDENTIFICATION

A. Provide and install metal tags.

1. Content: Valve Identification Number

2. Material: 316 stainless steel, smooth edge.

3. Legends: stamped letters.

4. Size: two inches diameter.

5. Fastening to Valves: stainless steel wire.

B. Valve Tag Sample: Submit one sample of a stamped Valve Tag.

C. Valve Schedule: Submit a complete schedule in compliance with the requirements of Sections 15095 and 15100.

2.04 EQUIPMENT IDENTIFICATION

A. Provide and mount the following two types of data plates.

1. Equipment Manufacturer's Data Plates

a. Content:

(1) Manufacturer's name;

(2) Model;

(3) Serial number;

(4) Size;

(5) Characteristics and approximate data describing the machine performance ratings.

b. Material: 316 stainless steel.

c. Legends: Stamped

d. Fastening to Equipment: Conspicuous location with No. 4 or larger oval head stainless steel screws. Plates shall not be painted over.

2. Equipment Identification Data Plates

a. Content: Equipment name and ID number.

b. Material: 1/16-inch laminated plastic.

c. Minimum Dimensions: 2 inches x 8 inches.

d. Maximum Dimensions: 3-1/2 inches x 12 inches.

e. Fastening to Equipment: With No. 4 oval head stainless steel screws. Alternative methods, if necessary, shall be approved by the Engineer.

f. Legends: Engraved, white letters on a black background, on two lines. Example:

(1) First Line: "RAW WATER PUMP"

(2) Second Line: "No. 3"

g. Minimum Letter Size: 5/8-inch high.

h. Maximum Letter Size: 1-1/4-inch high.

i. Nominal Limit of 18 letters, numerals and spaces.

j. Where equipment is mounted on roofs or where exposed to the public view such as in lobby or office areas, the color shall be selected by the Owner.

B. Data Plate Sample: Submit one sample of an engraved Equipment Identification Data Plate.

C. Data Plate List

1. Submit complete list of the Equipment Identification Data Plates.

2. The Equipment Identification Data Plates List shall provide:

a. Names of all the equipment,

b. Corresponding content of the data plates: equipment name and ID number.

3. If alternative fastening systems are proposed for any specific plate, it shall be so indicated on this list and a description of the method shall be attached to the list.

2.05 EQUIPMENT AND VALVES IDENTIFICATION NUMBERS

A. Identification numbers are indicated in the Documents. Any additional identification numbers will be designated by the Engineer when the Shop Drawings are submitted for review.

B. All identification numbers shown on the Drawings shall be included on the Shop Drawings.

C. For identification numbers not shown on the Drawings, the Contractor shall identify all such items during the initial submittal of any Shop Drawings. The Project Manager will assign these items identification numbers, and the Contractor shall incorporate these numbers on the Shop Drawings. The Contractor shall also incorporate identification numbers on the "As-Built" Drawings.

- END OF SECTION -

SECTION 15095

VALVES, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install, complete with all assemblies and accessories, all valves shown on the Drawings and specified herein including all fittings, appurtenances and transition pieces required for a complete and operable installation.

B. All valves shall be constructed of first quality materials which have strength, wearing, and corrosion resistance characteristics entirely suitable for the types of service for which the individual valves are designated. Except where noted otherwise, valves designated for water service shall conform to pertinent sections of the latest revision of AWWA C500 Specifications. Cast iron valve bodies and parts shall meet the requirements of the latest revision of ASTM Designation A-126, "Standard Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B."

C. All valve body castings shall be clean, sound, and without defects of any kind. No plugging, welding, or repairing of defects will be allowed.

D. Valves shall have flanged ends for exposed service and mechanical joint ends for buried service, unless otherwise shown on the Drawings or specified herein. Flanged ends shall be flat-faced, 125 lb. American Standard unless otherwise shown or specified in accordance with ANSI B16.1. All bolt heads and nuts shall be hexagonal of American Standard size. The Contractor shall be responsible for coordinating connecting piping. Valves with screwed ends shall be made tight with Teflon tape. Unions are required at all screwed joint valves.

1.02 SUBMITTALS

A. The Contractor shall furnish to the Owner a Performance Affidavit where required in individual valve specifications, utilizing the format specified in Section 11000, Equipment General Provisions. Performance tests shall be conducted in accordance with the latest revision of AWWA C500 and affidavits shall conform to the requirements of the Specifications

B. Shop Drawings conforming to the requirements of Section 01300, Submittals, are required for all valves, and accessories. Submittals shall include all layout dimensions, size and materials of construction for all components, information on support and anchoring where necessary, pneumatic and hydraulic characteristics and complete descriptive information to demonstrate full compliance with the Documents. Shop Drawings for electrically operated/controlled valves shall include all details, notes, and diagrams which clearly identify required coordination with the electrical power supply and remote status and alarm indicating devices. Electrical control schematic diagrams shall be submitted with the Shop Drawings for all electrical controls. Diagrams shall be drawn using a ladder-type format in accordance with JIC standards. Shop Drawings for pneumatically operated/controlled

valves shall include all details, notes, and diagrams which clearly identify required coordination with the compressed air (service air) system and electrical controls.

C. Operation and maintenance manuals and installation instructions shall be submitted for all valves and accessories in accordance with the Specifications. The manufacturer(s) shall delete all information which does not apply to the equipment being furnished.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall provide the services of a qualified representative of the manufacturer(s) of the equipment named below to check out and certify the installation(s), to supervise the initial operation, and to instruct the Owner's operating personnel in proper operation and maintenance procedures in accordance with the following schedule:

| Item | Valve/Operator Type | Minimum On-Site Time Requirements |
|---|---|---|
| 1. | Automatic Control Check Valve | One (1) 8-hour day |
| 2. | Surge Anticipators | One (1) 8-hour day |
| 3. | Motor Operated Modulating Valves | One (1) 8-hour day |
| 4. | Motor Operated Open-Close Valves (required only if manufacturer is other than for Item 3 above) | One (1) 8-hour day |
| 5. | Pneumatic Hydraulic Cylinder Operated Valves | One (1) 8-hour day |

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident Project Representative on each day he is at the project.

C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies notes.

D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

PART 2 -- PRODUCTS

2.01 FLOW INDICATORS

A. Flow indicators shall be the Akron ball-type as manufactured by Brooks Instrument Co., Fischer and Porter, or equal, and shall have bronze bodies, glass dome, and plastic ball.

2.02 CORPORATION STOPS

A. Corporation stops shall be of bronze with tapered male iron pipe threads on inlets and outlets. Terminal outlets shall have screwed bronze hex head dust plugs or caps. Unions shall be used on all corporation stop outlets with connecting piping. Corporation stops shall

have a minimum working pressure rating of 250 psi and shall be as manufactured by Mueller Co., Hays Mfg. Div. of Zurn Industries, or equal.

2.03 FLOOR BOXES

A. Floor boxes shall be provided for all nut operated or floor accessed valves. Floor boxes shall be of the adjustable, sliding type, cast iron, suitable to withstand heavy traffic, as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., or equal. The covers shall be marked with appropriate designations of piping contents (i.e.: water, sewer) and bases shall be the round type. All nut operated valves in this Section shall be clearly identified by stainless steel or laminated plastic identification tags. The tags shall be permanently affixed to the inside of the floor boxes, under grating, etc. and shall bear the embossed letters which clearly identify each valve by its appropriate designation.

B. Two (2) valve operating wrenches shall be supplied in 4 foot lengths with tee handles for each size nut supplied. Valve wrenches shall be Model No. F-2520 as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Figure No. 122, or equal.

2.04 VALVE BOXES

A. The Contractor shall furnish and install valve boxes as shown on the Drawings and specified herein.

B. All valve boxes shall be placed so as not to transmit shock or stress to the valve and shall be centered and plumb over the operating nut of the valve. The ground in the trench upon which the valve boxes rest shall be thoroughly compacted to prevent settlement. The boxes shall be fitted together securely and set so that the cover is flush with the finished grade of the adjacent surface. A concrete pad as detailed on the Drawings shall be provided around the valve box, sloped outwards.

C. All valve boxes shall be 2-piece cast iron, sliding type, 5-1/4" shaft, with heavy duty traffic weight collar and the lid marked with the appropriate carrier product (i.e.: WATER). Boxes shall be as manufactured by James B. Clow & Sons, Kennedy Valve Mfg. Co., Charlotte Pipe and Foundry Company, or equal.

2.05 STRAINERS

A. Y-Strainers shall be Y-pattern cast iron body, flanged or screwed ends with stainless steel or Monel, 20 mesh strainers. Strainers shall be 200 psi, cold-water service strainers, as manufactured by WATTS, Crane Co., Zurn, or equal.

B. Stainless steel Y-strainers shall be provided as shown on the drawings. Strainers shall be full port-full flow design manufactured of 304 or 316 stainless steel body. Y-strainers shall be furnished with flanged ends. The strainer screen shall be 1/32-inch perforation, easily removable, manufactured of the same material as the valve body.

C. PVC and CPVC y-strainers shall be provided in PVC and CPVC piping and as shown on the Drawings. Strainer shall be provided with PVC or CPVC body and end cap, EPDM or Viton seal as required for the chemical service, and 20 mesh screen. Temperature rating shall be 30°F to 140°F, and pressure rating shall be 150 psi. PVC and CPVC y-Strainers shall be as manufactured by Asahi/America, Hayward, or equal.

D. Manually cleaned strainers shall be the duplex basket tapered plug type.

1. Strainers 3-inches in diameter and larger shall have flanged ends conforming to ANSI B16.1-125/150 pound standard.

2. Strainers less than 3-inches in diameter shall have screwed end connectors, unless otherwise shown on the Drawings.

3. Strainers shall be constructed with an ASTM A48, Class 30 cast iron body, ductile iron trim, removable 0.045 inch staggered hole perforation, 304 stainless steel filter baskets and gauges on the inlet and outlet.

4. All strainers shall be suitable for 125 psi service.

5. Switching flow from one basket to the other shall be accomplished by moving the handle through a 180° arc. The switching operation shall not stop flow through the strainer and shall provide for on-line removal of either basket with the other basket functional. The plug shall be automatically positioned with integral stops and shall be easily lifted and reseated under pressure.

6. The strainer shall be designed to minimize the possibility of material bypassing the plug while being rotated and to prevent debris from building up under the plug. The strainer covers shall be designed for quick opening with swing away yoke.

7. Each basket compartment shall have a side drain outlet.

8. All strainers shall be provided with support legs.

9. Duplex basket strainers shall be similar to the Model 53BTX as manufactured by Hayward, or equal.

2.06 QUICK DISCONNECT COUPLINGS

A. Quick disconnect type coupling for compressed/service air shall be provided where indicated on the Drawings. Coupling shall provide for instantaneous shutoff in socket end when lines are disconnected. Couplings shall be constructed of 316 stainless steel with a BUNA-N O-ring and integral safety lock. Couplings shall comply with Military Specification 4109 (interchangeable with standard plug of the same size).

2.07 BACKFLOW PREVENTERS

A. Backflow preventer shall be the size shown on the Drawings and shall be of the double check valve principle. Backflow preventer installation shall include isolation valves and four test cocks, furnished as an assembly. For backflow preventers less than 2-1/2", the installation assembly also shall include a strainer. Isolation valves for backflow preventers shall be ball valves, except for size 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The backflow preventer shall be a WATTS 709, or equal.

B. Reduced Pressure Backflow Preventer shall be of the size shown on the Drawings, and shall be of the reduced pressure principle type in accordance with AWWA Standards C510 and C511, with two (2) independent operating spring loaded check valves and one (1)

spring loaded, diaphragm actuated, differential pressure relief valve shall be installed between the check valves. Backflow preventer shall be bronze body construction, with EPT rubber discs and Buna-N and nylon diaphragm. Screws and springs shall be of stainless steel. End connections shall be screwed, unless otherwise specified or shown on the Drawings. Reduced pressure backflow preventer installations shall include isolation valves and four test cocks, furnished as an assembly. For reduced pressure backflow preventers less than 2-1/2" the installation assembly also shall include a strainer. Isolation valves for reduced pressure backflow preventers shall be ball valves, except for sizes 2-1/2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The reduced pressure backflow preventer shall be as manufactured by Beeco Division, Hersey Products Inc., Aergap Model 6CM, WATTS 909, or equal.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. Except where noted otherwise herein, all valves shall be installing and tested in accordance with the latest revision of AWWA C500. Before installation, all valves shall be lubricated, manually opened and closed to check their operation and the interior of the valves shall be thoroughly cleaned. Valves shall be placed in the positions shown on the Drawings. Joints shall be made as directed under the Piping Specifications. The valves shall be so located that they are easily accessible for operating purposes, and shall bear no stresses due to loads from the adjacent pipe. The Contractor shall be responsible for coordinating connecting piping.

B. All valves shall be tested at the operating pressures at which the particular line will be used. Any leakage or "sweating" of joints shall be stopped, and all joints shall be tight. All motor operated and cylinder operated valves shall be tested for control operation as directed by the Engineer.

C. Provide valves in quantity, size, and type with all required accessories as shown on the Drawings.

D. Install all valves and appurtenances in accordance with manufacturer's instructions. Install suitable corporation stops at all points shown or required where air binding of pipe lines might occur. Install all valves so that operating handwheels or wrenches may be conveniently turned from operating floor but without interfering with access, and as approved by Engineer. Unless otherwise approved, install all valves plumb and level. Valves shall be installed free from distortion and strain caused by misaligned piping, equipment or other causes.

E. Valve boxes shall be set plumb, and centered with the bodies directly over the valves so that traffic loads are not transmitted to the valve. Earth fill shall be carefully tamped around each valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face, if less than 4 feet.

### 3.02 SHOP AND FIELD TESTING

A. Shop and field testing of valves shall be as follows:

1. Certified factory testing shall be provided for all components of the valve and operator system. Valves and operators shall be shop tested in accordance with the requirements in the latest revision of AWWA C500, including performance tests, leakage test, hydrostatic tests, and proof-of-design tests. The manufacturer through the Contractor shall submit certified copies of the reports covering the test for acceptance by the Engineer.

2. Shop testing shall be provided for the operators consisting of a complete functional check of each unit. Any deficiencies found in shop testing shall be corrected prior to shipment. The system supplier through the Contractor shall submit written certification that shop tests for the electrical/pneumatic system and all controls were successfully conducted and that these components provide the functions specified and required for proper operation of the valve operator system.

3. The Contractor shall conduct field tests to check and adjust system components, and to test and adjust operation of the overall system. Preliminary field tests shall be conducted prior to start-up with final field tests conducted during start-up. The factory service representative shall assist the Contractor during all field testing and prepare a written report describing test methods, and changes made during the testing, and summarizing test results. The service representative shall certify proper operation of the valve operator system upon successful completion of the final acceptance field testing.

4. Preliminary and final field tests shall be conducted at a time approved by the Engineer and Owner. The Engineer shall witness all field testing.

5. All costs in connection with field testing of equipment such as energy, light, lubricants, water, instruments, labor, equipment, temporary facilities for test purposes, etc. shall be borne by the Contractor. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods and shall neither have nor make any claim for damage which may occur to equipment prior to the time when the Owner formally takes over the operation thereof.

6. Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components. Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly. The preliminary field test report must be approved by the Engineer prior to conducting final field acceptance tests. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation specified or otherwise directed by the Engineer

7. Final field acceptance tests shall be conducted simultaneously with the start-up and field testing of the pumps, air compressors, process air blowers, etc. Field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing. Performance of pneumatic valves and compressed air system under normal operating conditions and during simulated power failures shall be checked.

8. Field testing shall include optimization of opening and closing times of the valves. The Contractor shall provide the means for accurate measurement of pipeline pressures as directed by the Engineer. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

- END OF SECTION -

# SECTION 15100

# VALVE OPERATORS AND ELECTRIC VALVE ACTUATORS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Equipment shall be provided in accordance with the requirements of Section 11000 – Equipment General Provisions and Section 15000 – Basic Mechanical Requirements.

B. Reference Section 15390 – Schedules for additional information on valves and operators/actuators.

C. The electric valve actuators shall meet the signal requirements described in Section 17060- Signal Coordination Requirements, Section 17920 – Control System Input/Output Schedule and 17950 – Functional Control Descriptions.

D. Valve operators and electric valve actuators shall be designed to unseat, open or close, and seat the valve under the most adverse operating condition to which the valves will be subjected.

E. Operator mounting arrangements shall be as indicated on the Drawings or as directed by the manufacturer and/or Engineer. There shall be no mounting restrictions on the electric valve actuator.

F. The valve operators and electric actuators shall be the full and undivided responsibility of the valve manufacturer in order to ensure complete coordination of the components and to provide unit responsibility.

### 1.02 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300, Submittals; and Section 11000, Equipment General Provisions:

1. Certification that the force required to operate all valves is as specified herein.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

A. Electric actuators shall be provided where specified in the Valve Schedule in Section 15390 – Schedules.

B. Manual operators shall be provided on all valves which do not receive electric actuators. Manual operator type shall be as specified herein and as shown on the Drawings.

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C. Quarter turn valves 8” and greater in size shall have geared operators. Gate valves 14” and greater in size shall have geared operators.

D. Operators/actuators shall be furnished with conservatively sized extension bonnets, extension stems, or torque tubes, and all required appurtenances required for a complete installation. Operators furnished with extension bonnets shall include stainless steel extension stems, or stainless steel torque tubes.

2.02 MANUAL OPERATORS

A. Unless otherwise specified or shown on the Drawings, manual operator type shall be as follows:

1. Buried valves shall be equipped with nut operators, extended stems, and valve boxes.

2. Exposed valves up to 6-inch shall be lever operated (except gate valves).

3. Exposed valves 8-inches and larger shall be handwheel operated.

4. Exposed gate valves shall be handwheel operated.

5. Valves with centerline of operator located more than 6-feet above the floor or platform from which it is to be operated shall have a chainwheel operator. unless otherwise indicated on the Drawings.

B. Manual operators shall be rigidly attached to the valve body unless otherwise specified or shown on the Drawings.

C. All operators shall turn counter-clockwise to open and shall have the open direction clearly and permanently marked.

D. Valve operators shall be designed so that the force required to operate the handwheel, lever, or chain (including breakaway torque requirements) does not exceed 80 pounds applied at the extremity of handwheel or chainwheel operator. Design pressures for sizing of valve operators shall be the piping test pressure for the piping in which the valve is to be installed as shown in the Piping Schedule in Section 15390 – Schedules.

E. Handwheels for valves operators shall not be less than 12 inches in diameter. The maximum diameter of any handwheel shall not exceed 24”.

F. Nut operators shall have standard 2-inch square AWWA operating nuts designed in accordance with AWWA C504-94.

G. Geared manual operators shall be of the worm gear, traveling nut or scotch yolk type except manual operators for butterfly valves 18-inch in diameter or larger which shall be worm gear, unless otherwise indicated in the individual valve specification. Gear operators shall be of the worm gear or bevel gear type. Gear box designs incorporating end of travel stops in the housing shall be equipped with AWWA input stops. Each gearbox shall require a minimum of 10 turns for 90 degree rotation or full valve stem travel and shall be equipped with a mechanical valve position indicator.

H. Manual operators on below grade (and vault installed) valves shall be permanently lubricated and watertight under an external water pressure of 10 psi.

2.03 ELECTRIC VALVE ACTUATORS

A. Electric Actuators shall be open/close service or modulating service as specified in the Valve Schedule in Section 15390 – Schedules.

1. Open/Close (non-modulating) valve actuators shall be SA series as manufactured by AUMA, or Series 2000 as manufactured by EIM Controls.

2. Modulating valve actuators shall be manufactured by Beck or Rexa.

B. Performance Requirements

1. The actuators shall be designed for indoor and outdoor service and shall be capable of mounting in any position.

2. Torque capacity of the actuators shall be sufficient to operate the valves with the maximum pressure differential, as indicated in the Valve Schedule in Section 15390, with a safety factor of 1.5. Actuators in modulating service will be selected such that the required dynamic valve torque is no more than 60% of the electric actuator's maximum rated breakaway of torque.

3. Operating time for full limits of travel shall be not more than 2 seconds per inch diameter of the valve, +/- 50 percent through 20 inches; +/- 30 percent for valves 24 inches and larger. Operating time shall not be less than 60 seconds for all modulating valves.

4. Actuators shall be capable of operating in ambient temperatures ranging from 0 degrees F – 160 degrees F.

5. For open/close (non-modulating) actuators, the gearing, motor and contactor shall be capable of up to 600 starts per hour without overheating.

6. For modulating actuators, the gearing, motor and contactor shall be capable of up to 1200 starts per hour without overheating.

C. The actuators shall include, in one integral housing, individual compartments for the motor, gearing, wiring terminals, and control circuits. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal. The inner seal shall protect the motor and all other internal electrical elements of the actuator from entrance of moisture and dust when the terminal cover is removed. Double cartridge shaft seals shall be provided on the hand wheel and output shafts for weatherproof protection. All external fasteners shall be stainless steel. Compartments shall be provided with moisture and dust-proof rigid cast covers meeting NEMA 6, certified to submergence in 6 ft of water for 30 minutes. Actuators located in classified areas shall be suitable for use in Class 1, Division 1, Group D environments.

D. The actuators shall be provided with externally operable and lockable 480VAC circuit breakers integral to the control housing.

E. All gearing shall be hardened alloy steel or bronze and shall be rated at twice the output torque of the operator and shall be designed to withstand the stall torque of the motor without failure. Output drive gearing shall consist of a worm shaft and worm gear pinion operating in an oil bath. The worm gear pinion shall be alloy bronze. Worm gear drive shall be self-locking to prevent creeping of the valve disc in an intermediate position. Heavy-duty grease shall protect gearing and sealed ball bearings of the main shaft for five years without changing. Motor reduction gearing shall be spur or planetary gearing and shall allow for field repair and change in gear ratio. For quarter turn applications, overtravel of the operator shall be prevented by internal mechanical stops cast into the actuator.

F. A mechanical dial position indicator shall be furnished to continuously indicate the position of the valve at and between the fully open and fully closed positions. The indicator shall be driven by gearing driven off of the main worm gear pinion and shall operate when the actuator is in either the electrical mode or manual mode.

G. A handwheel shall be permanently attached for manual operation. A gear assembly shall be provided between the handwheel and the worm shaft if required to reduce the force necessary to operate the handwheel to less than 40 pounds. A positive declutch mechanism shall engage the handwheel when required. When the actuator is set in the declutched position for handwheel operation, it shall return automatically to electric operation when actuator motor is energized. The handwheel shall not rotate during electric operation nor shall a fused motor prevent handwheel operation.

H. The drive motor shall be specifically designed for actuator service and shall be characterized by high starting torque and low inertia. Motors shall be 460 volts, three phase, 60 Hz AC reversible squirrel cage induction type motors and shall be specifically designed for modulating service where indicated on the Valve Schedule in Section 15390. Motors shall be totally enclosed, non-ventilated, with NEMA Class F insulation minimum (Class H for modulating actuators) and a maximum continuous temperature rating of 120 degree C (rise plus ambient). A 120 VAC space heater shall be provided in the motor compartment. The electric motor shall have a time rating of at least 15 minutes at 104°F (40°C) or twice the valve stroking time, whichever is longer, at an average load of at least 33% of maximum valve torque. Motor bearings shall be permanently lubricated by premium lubricant. The motor shall have plug and socket electrical connection to facilitate easy removal and replacement. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel with either phase sequence of the three-phase power supply connected to the actuator. The motor shall include single phase protection. A suitable thermal protection device shall be incorporated in the motor or motor starter circuits, connected to a tripping device. Fast acting fuses shall be provided to protect solid state components. The motor shall be capable of starting against the rated load in either the open or close direction when voltage to the motor terminals is plus or minus ten (10) percent of nameplate rating.

1. Open/Close actuators shall be furnished with electro-mechanical reversing starters.

2. Modulating actuators shall be furnished with solid state reversing starters utilizing thyristors.

I. Leads from the motor shall be brought to the control circuit (limit switch) compartment without external piping or conduit box. An adequately sized space heater shall be installed in the control circuit compartment to aid in the prevention of damage resulting in from condensation. The following items shall be located in the control circuit compartment.

1. Torque limit switches shall be provided to de-energize the motor control circuit in the event of a stall when attempting to unseat a jammed valve and when torque is exceeded during valve travel. Each actuator shall have an open direction torque switch and a close direction torque switch. The torque switches shall be mechanically operated and able to be set in torque units. Torque switches shall be calibrated prior to the actuator's assembly to the valve.

2. Travel limit switches shall be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions. The limit switch drive shall be of the counter gear type and "in step'" with the actuator output drive at all times in either the electrical or manual mode of operation. A minimum of six (6) contacts, three (3) normally open and three (3) normally closed, shall be supplied at each end of valve travel. Four (4) additional contacts shall be provided to report end of travel or any desired position between ends of travel.

J. Modulating actuators shall have a position feedback potentiometer mounted directly to the valve actuator gearing inside the gearing compartment. The potentiometer shall provide a 4-20 mA signal corresponding to valve position. Modulating valve actuators shall be designed to respond to either a 4-20mADC analog signal or a digital pulse signal as specified herein or as required to coordinate with the requirements of Division 17.

1. Modulating valve actuators designed to respond to a 4-20mADC signal shall be provided with a valve positioner which shall position the valve proportional to an externally generated 4-20mADC signal. The valve positioning control circuitry shall position the valve by comparing the command signal with the present valve position as indicated by the feedback potentiometer. The positioner shall be field adjustable to fail to the "open," "closed," or "last" position on loss of 4-20 mADC command signal.

2. Modulating valve actuators designed to respond to "pulse" open/close signals shall operate the valve during the time the open or close pulse signal is high. Modulating actuators designed to respond to "pulse" open/close signals shall have the latching circuitry described above for open/close actuators disabled.

K. The electrical terminals shall be housed in a double sealed terminal compartment isolated from the rest of the actuator components. The actuators shall be designed to operate from a single 480VAC, 3-phase source. The actuators shall be furnished with fuses inside of the terminal compartment. A quantity of two – ¾ inch NPT conduit entries shall be furnished.

L. Actuators shall contain wiring and terminals for the following control functions. All dry contacts shall be rated for 5A at 250VAC.

1. Open, Close, and Stop commands from external dry contacts (utilizing internal 24VDC power supply) and/or from an external signal of 12V to 120V. The inputs

for the open, close, stop signals shall be field selectable to be respond to either maintained or momentary remote signals. In momentary mode, the actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact signal unless a stop signal is received.

2. Emergency override input from a normally closed or normally open contact. The actuator shall either open or close (field selectable) upon receiving the emergency override input.

3. Remote Local-Off-Remote selector switch, Open/Close pushbuttons, and Open/Closed pilot lights for a remote manual control station (see below). The remote Local-Off-Remote selector switch and Open/Close pushbuttons shall be a dry contact input to the actuator control circuitry. The Open/Closed pilot lights shall be powered from the valve actuator control power.

4. Four (4) unpowered contacts shall be provided which can be selected to indicate valve "Opened" and "Closed" position, "Remote" status of the actuator, and fail status of the actuator. The fail status contacts shall activate upon motor overtemperature and actuator overtorque as a minimum.

5. Terminals for 4-20mADC position command and 4-20mADC position feedback as described above for modulating actuators.

M. Local Controls

1. Actuators shall be furnished with a Local-Off-Remote selector switch; Open, Close, and Stop pushbuttons for local control; a red lamp indicating closed and a green lamp indicating open. L-O-R switch shall be padlockable in any of the three positions.

   a. When the LOR is in the "Local" position, open/close control shall be by the open and close pushbuttons on the actuator. The stop push button shall stop the actuator travel.

   b. When the LOR is in the "Off" position, the actuator shall not operate.

   c. When the LOR is in the "Remote" position, the actuator shall be controlled by remote inputs from the PLC or from the remote manual controls station.

2. The local controls shall be arranged so that the direction of travel can be reversed without the necessity of stopping the actuator.

N. Remote Manual Control Station

1. Where indicated in the Valve Schedule in Section 15390 – Schedules, manual actuator controls shall be furnished in a separate NEMA 4X stainless steel enclosure (NEMA 7 if located in a classified area). Manual control station controls shall include Hand–Off-Auto Selector switch; Open, Stop, and Close pushbuttons; a red lamp indicating closed and a green lamp indicating open.

a. When the HOA is in the “Hand” position, open/close control shall be by the open and close pushbuttons on the remote manual control station. The stop push button shall stop actuator travel.

b. When the HOA is in the “Off” position, the actuator shall not operate.

c. When the HOA is in the “Auto” position, the actuator shall be controlled by remote inputs to the valve actuator from the PLC.

2.04 ELECTRIC OPERATORS FOR PVC/CPVC VALVES

A. Automatic electric operators shall be provided for PVC/CPVC valves where specified and/or as shown on the Drawings. Operators shall operate on 120 volt AC, single phase, 60 hertz power and be equipped with solid state electronic internal controls. Motors shall be brushless, capacitor-run, reversing type, suitable for high duty cycle applications and shall be specifically designed for open/close service. Motors shall be provided with integral thermal overload protection with auto-reset. Operator gears and shafts shall be constructed of heat treated high-alloy steel. Operator output shaft shall be electro-less nickel plated. Operator gear trains shall be permanently lubricated. The gear train shall withstand operator stall torque. Operator enclosures shall be NEMA 4. Operators shall be provided with internally wired, thermostatically controlled enclosure heaters to maintain an enclosure temperature of at least 40 degrees F. Operators shall be provided with positive visual position indication markings permanently affixed to the operator body and final output shaft. Operator drive output shall be provided with a declutchable manual override. A manual lever shall be provided for manual valve positioning. Operators shall be failsafe, utilizing a mechanical spring with a clutch mechanism to uncouple the motor during spring return operation, allowing the spring to relax and either open or close the valve. Selection of either fail-opened or fail-closed shall be made by selection of field wiring terminals.

B. Independently adjustable cam-operated position limit switches shall be provided with dry contacts for remote fully opened and fully closed valve position indication. Operators shall respond to external dry contact open/close controls. The actuator shall have internal latching circuitry that causes the operator to drive the valve to its limit of travel upon receipt of the momentary contact open or close signal unless a stop signal is received. The all actuator control circuitry, including latching circuitry, shall be internal to the valve actuator. Valve control circuits and components mounted in a separate enclosure external to the valve actuator assembly will not be permitted. Connections for external remote controls shall be powered from an internal 24VDC or 120VAC power supply. Limit switches shall be rated for 15 amps at 120 VAC. Valve remote status shall also be provided as specified in Section 17950. The Contractor shall coordinate operator controls with the functional requirements specified in Section 17950 – Functional Control Descriptions.

## PART 3 -- EXECUTION

3.01 MANUFACTURER’S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000, Equipment General Provisions and shall include the following site visits for electric actuators:

| Service | Number of Trips | Number of Days/Trip |
|---|---|---|
| Installation and Testing | 1 | 1 |
| Startup and Training | 1 | 1 |
| Services after Startup | 1 | 1 |

3.02 INSTALLATION

A. All valve actuators shall be installed in accordance with the manufacturer's published recommendations and the applicable specification sections for valves, and motor controls.

B. Valve actuators shall be factory coated in accordance with the manufacturer's standard paint system.

3.03 SHOP TESTING

A. Shop testing shall be in accordance with Section 11000, Equipment General Provisions and with the following additional requirements:

1. Conduct a complete functional check of each unit. Correct any deficiencies found in shop testing prior to shipment.

2. Submit written certification that:

a. Shop tests for the electrical system and all controls were successfully conducted;

b. Electrical system and all controls provide the functions specified and required for proper operation of the valve operator system.

3. Each actuator shall be performance tested and individual test certificates shall be supplied free of charge. The test equipment shall simulate each typical valve load and the following parameters should be recorded:

a. Current at maximum torque setting

b. Torque at maximum torque setting

c. Flash Test Voltage

d. Actuator Output Speed or Operating Time

e. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram code number.

f. Verification of actuator torque rating with valve.

3.04 FIELD TESTS

A. Field testing shall be in accordance with the following additional requirements:

1. Valve actuators shall be field-tested together with the associated valves.

2. Test all valves at the operating pressures at which the particular line will be used.

3. Test all valves for control operation as directed.

4. Field testing shall include optimization of opening and closing times of the valves. Valve opening and closing times shall be adjusted based on process requirements to optimize operation of the valves. Final valve opening and closing times as determined by field tests shall be approved by the Engineer prior to final acceptance of the system.

B. Preliminary Field Tests

1. General: Preliminary field tests shall be conducted prior to start-up and shall include a functional check of the entire valve operator system and all system components.

2. Scope: Preliminary field tests shall demonstrate that the valve operator system performs according to specifications and that all equipment, valves, controls, alarms, interlocks, etc., function properly.

3. Based on results of preliminary field tests, the Contractor shall make any adjustments required to settings, etc., to achieve the required valve closing time and operation, as specified or otherwise directed.

C. Final Field Tests

1. Final field tests shall be conducted in accordance with the latest revision of AWWA C500.

2. Final field tests shall be conducted simultaneously with the start-up and field testing of the pumps.

3. Final field tests shall be conducted for the full range of operating modes and conditions specified and as directed by the Engineer. Each of the valves shall be tested at minimum, maximum, and normal head/flow conditions, and under all specified conditions of opening and closing.

4. Certification of Equipment Compliance: After the final field tests are completed and passed, submit affidavit.

- END OF SECTION -

SECTION 15101

BUTTERFLY VALVES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

## PART 2 -- PRODUCTS

### 2.01 BUTTERFLY VALVES (WATER SERVICE)

A. Butterfly valves (water service) shall be of the rubber-seated, tight-closing type conforming to the latest revision of AWWA C504 Specifications. The manufacturer shall have a minimum of 5 years experience in manufacturing butterfly valves of the sizes required in accordance with AWWA C504 Specifications. All butterfly valves shall be the product of one manufacturer. Butterfly valves shall be as manufactured by DeZurik, Pratt, or equal. Each valve shall be performance and leak tested as specified in AWWA C504 revised as follows: In addition to the testing requirements of AWWA C504, each butterfly valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.

B. Butterfly valves shall be Class 250B, unless otherwise indicated in the valve schedules, and of the short body design with mechanical joint or flanged ends, as shown on the Drawings.

C. Valve bodies shall be epoxy coated cast iron conforming to ASTM A-126, Grade B, ASTM A-48, Class 40 or Ductile Iron ASTM A536, Grade 65-45-12. Where required to meet design operating conditions, valve bodies shall be manufactured of higher strength materials. Valve bodies shall have integral hubs for housing shaft bearings and seals.

D. Butterfly valves shall be of the concentric or eccentric shaft types. Valve discs shall be constructed of epoxy coated ductile iron, ASTM A536, Grade 65-45-12. Disks shall be of the "offset" design to provide a full 360 degree seating surface with no external ribs transverse to flow, and shall comply with the latest revision of AWWA C504 Specifications. The valve manufacturer shall furnish Shop Drawings which include end clearance dimensions when the disc is in the full open position.

E. The resilient valve seat shall be synthetic rubber designed to seat against a pressure differential of 150 psi on either side of the valve, unless otherwise indicated. The resilient seat shall be mechanically attached to the valve disc or valve body. Any required seat attachment hardware shall be stainless steel. The resilient seat shall be capable of being adjusted or replaced in the field without moving the valve disc along the shaft axis, or removing the valve from the line. The mating seat surface shall be stainless steel or monel.

The seats shall be factory tested as per AWWA C504 at a test pressure of 150 psig, unless otherwise indicated, and post adjusted for differential pressures indicated herein.

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F. Valve shafts shall be one-piece or two-piece units of stainless steel construction suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve disc by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material.

G. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of teflon or heavy-duty bronze. The valve assembly shall be furnished with a factory set two-way thrust bearing designed to center the valve disc in the valve seat at all times. End cover bolts shall be of stainless steel construction.

H. The shaft seal shall be either the bronze cartridge type with at least two O-rings, monolithic V-Type, or pull down packing type. If monolithic V-Type or pull down packings are utilized, it shall be self-adjusting, self-compensating type. Packing shall be as manufactured by Chevron, or equal. Butterfly valves with pull down packings shall be designed with an extension bonnet so that repacking can be done without removal of the actuator. For buried valves with pull down packing the packing gland cover assembly shall be heavy duty, soil and water resistant. Stuffing boxes for pull down packing shall have a depth sufficient to accept at least four rings of self-compensating type packing specifically selected for the operating pressures to be encountered. Stuffing box bolts, studs and nuts shall be stainless steel.

I. The "O" ring type shaft seal shall be contained in a removable bronze cartridge. The bronze cartridge shall be manufactured from ASTM B505 copper alloy UNS #C93200 and shall meet the requirements of AWWA C504 for bronze, Grade E. The "O" ring material shall be nitrile, BUNA-N rubber, as intended for use with potable water or wastewater and per ASTM D-2000 with a hardness of 70 Shore A Durometer.

J. Manual operators for butterfly valves 18-inches in diameter or larger shall be the worm gear type conforming to AWWA C504. Manual operators for butterfly valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops, shall be sized according to Table IV for Class 150B, and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under the differential pressure of 150 psi and maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule.

K. The manufacturer shall certify that the butterfly valves are capable of operating in continuous duty service under these pressures and flow conditions.

L. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

M. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

2.02 BUTTERFLY VALVES (PROCESS AIR)

A. Isolation valves and throttling valves for low pressure (less than 15 psig) air service shall be rubber seated, conforming to AWWA C504, 25 psi working pressure, with ANSI B16.1 flanges, 125 pound rating. Valves shall otherwise be as described above under Butterfly Valves (Water Service), except that all valve elements including seat shall be capable of withstanding continuous operation at 250°F.

2.03 BUTTERFLY VALVES (PVC/CPVC)

A. Butterfly valves (PVC/CPVC) shall be wafer style, constructed of solid Class 12454-B PVC or Class 23447-B CPVC with polypropylene disc and EPDM seats and seals. Valves intended for chemical service shall be constructed of materials suitable for the intended service. Butterfly valves shall provide bubble-tight seating, with stainless steel shaft and gear operator, and shall be as manufactured by ASAHI/AMERICA, or equal.

2.04 BUTTERFLY VALVES (RECTANGULAR)

A. Rectangular butterfly valves shall be bubble tight with flow in either direction. Rectangular butterfly valves shall be manufactured by Pratt, Hydro Gate, or equal. The Valve body shall be fabricated carbon steel, designed for wall mounting. Valve manufacturer shall provide a double flanged wall thimble to be cast in place. The valve disc shall be fabricated of carbon steel with Type 304 stainless steel seating edge. Disc shall be streamlined in shape to prevent turbulence in full open position and to minimize pressure drop across valve. The valve seat, contained in the body of the valve, shall be a synthetic rubber compound with a durometer of 50.

B. Seat adjustment shall not be less than 1/8 inch. Valve seat shall be fully field adjustable and replaceable without dismantling operator, disc, or shaft and without the use of special tools. Valve shaft shall be 304 stainless steel securely locked to disc by stainless steel taper pins.

C. Each valve assembly shall be furnished with a 2-way thrust bearing assembly designed to hold the disc centered in the seat at all times. Thrust bearing shall be secured by locking device and easily accessible for field adjustment from operator end of valve.

D. Valve operators shall conform to AWWA-C504 and shall be designed to hold the valve in any intermediate position between fully closed and fully open without creeping or fluttering. Manual operators shall be of the travelling nut, self-locking type and shall be equipped with mechanical stop-limiting devices to prevent over travel of the disc. Operators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 lb. on the handwheel.

E. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

F. The manufacturer shall certify that the rectangular butterfly valves are capable of operating in continuous duty service under the required pressures and flow conditions. Each valve

shall be hydrostatically tested and tested for bubble-tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

- END OF SECTION -

SECTION 15104

BALL VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves removed for chemical service shall be constructed of materials suitable for the intended service.

PART 2 -- PRODUCTS

2.01 BALL VALVES (WATER SERVICE)

A. Ball valves (water service) shall be of the full port, single seated, metal to metal seated, tight-closing type conforming to the latest revision of AWWA C507 Specifications. The manufacturer shall have a minimum of 5 years experience in manufacturing ball valves of the sizes required in accordance with AWWA C507 Specifications. All ball valves shall be the product of one manufacturer. Ball valves shall be as manufactured by Conbraco, Nibco or Watts.

B. Each valve shall be performance and leak tested as specified in AWWA C507 revised as follows: In addition to the testing requirements of AWWA C507, each ball valve shall be thoroughly cleaned and opened and closed at least three (3) times prior to testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.

C. Ball valves shall be AWWA Class 150, unless otherwise indicated in the valve schedules, design with flanged ends, and installed as shown on the Drawings.

D. The valve body shall be constructed of epoxy coated cast iron conforming to ASTM A 48, Class 35, with a full, unrestricted circular inlet and outlet, with nominal opening diameter equal to the rated size of the valve. Each valve body shall be provided with flanged ends conforming in diameter and drilling to ANSI B16.1, Class 125. All flanges shall be flat faced and finished to true plan surfaces within a tolerance limit of 0.005 inch. Each flange face shall be perpendicular to the longitudinal axis of the valve within a maximum angular variation tolerance of 0.002 inch per foot of flange diameter. Flange faces shall have concentric or spiral serrated finish. The body trunnions shall be fitted with ample sized bronze bearings of sufficient difference in hardness from the plug bearings to eliminate seizing and galling. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing teflon coated or other non-metallic material will not be acceptable. Bearings shall be machined in accurate alignment for reception of the plug trunnions.

E. The body shall provide rigid means for supporting the valve operating mechanism without the necessity of additional supports and shall be of such design that it shall be capable of

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receiving the complete plug sub assembly. The valve body shall have integral hubs for housing shaft bearings and seals.

F. The body shall have a rigidly attached metal seat. The body seat shall be Monel (Alloy 400) and shall be machined, ground and polished for contact with the stainless steel seat mounted on the plug.

G. There shall be two (2) pipe connections, one for an air vent and the other for drain.

H. The plug shall be constructed of epoxy coated cast iron conforming to ASTM A48, Class 35, with a full unobstructed, circular waterway with a diameter equal to the rated size of the valve. It shall have trunnion supports cast integral on the axis of rotation. An extension of one trunnion, called the operating shaft, shall pass through a shaft seal chamber and connect to the valve operation mechanism.

I. The plug shall have a stainless steel seat conforming to ASTM A276, Type 304, mounted thereon which shall properly align with the body seat when the valve is in the closed position. The surfaces of the seat ring shall be spherically generated and shall be machined, ground and polished for contact with the body seat.

J. The plug trunnions shall be fitted with bronze bearings of sufficient difference in hardness from the body bushings to eliminate seizing and galling.

K. Bearing pressure shall not exceed 1500 psi at full differential pressure of 150 psi. Valve designs employing Teflon coated or other non-metallic bearing material will not be acceptable.

L. Valve shafts shall be integral with the plug and shall connect the plug to the torque unit. The shaft shall be of chrome Molybdenum Steel (ASTM A 322 Grade 4140) with hard chrome plate through the seal chamber suitably sized to transmit the torques required to operate the valves under the conditions listed in the valve schedule with appropriate safety factor. Shafts shall be securely attached to valve plug by means of conservatively sized corrosion-resistant taper pins, threaded at one end and secured with lockwashers and nuts (i.e.: mechanically attached). Provide O-ring seal on taper pin if required to prevent leakage. Shaft key shall be constructed of corrosion-resistant material.

M. Shaft bearings shall be contained in the integral hubs of the valve body and shall be the permanently self-lubricated, corrosion resistant, sleeve type of heavy-duty bronze. The valve assembly shall be furnished with a factory set thrust bearing designed to center the valve plug in the valve seat at all times. End cover bolts shall be of stainless steel construction.

N. A shaft seal shall be provided of the type utilizing a plug shaft stuffing box, four (4) "O" ring seals, a bronze retainer and a corrosion resistant steel lock ring. The "O" ring material shall be BUNA-N rubber, as intended for use with potable water or wastewater.

O. Manual operators for ball valves 18-inches in diameter or larger shall be the worm gear or travelling nut type conforming to AWWA C507. Manual operators for ball valves mounted above 6 feet from the operating floor shall be equipped with worm gear chainwheel actuators. Operators shall be equipped with adjustable AWWA limit stops and shall require a minimum of 15 turns for 90 degrees or full stem valve travel. The capacity of the manual operator shall be adequate to drive the valve under the differential pressure of 150 psi and

maximum anticipated flow, unless otherwise indicated in the appropriate valve schedule. Electric motor operators shall be as specified elsewhere in this Section.

P. The torque unit (valve operating mechanism) shall be of the traveling-nut type and shall be the product of the valve manufacturer. The assembly shall be mounted, and attached to the valve body. The torque unit shall be designed to accept a manual, cylinder or electric motor actuator. The torque unit housing shall employ the following:

1. A traveling crosshead to impart positive rotary movement to the plug which will move transversely to the valve shaft.

2. A cylinder piston rod or stainless steel Type 416 threaded leadscrew (reach rod or stem) with the crosshead directly attached thereto.

3. A rotator lever (of cast steel construction).

4. A matched set of interconnecting links (of cast steel construction) connecting the traveling crosshead to the rotator lever.

Q. The traveling crosshead shall be confined to permit linear motion only and to prevent it from any tendency to rotate due to linkage reaction. A plug shaft support bearing shall be supplied on the cover.

R. The torque unit shall be so designed that during the first 50 percent of stroke in closing the flow area is reduced by approximately 81 percent. The remaining 19 percent of flow area shall be gradually reduced to a complete shutoff throughout the last 50 percent of the closing stroke.

S. The torque unit shall be totally enclosed in a suitable housing with a removable cover and shall be capable of being inspected, lubricated, adjusted and repaired without interfering with or removing the valve from the line and shall be permanently lubricated. All parts shall be of first class workmanship, easily replaceable and manufactured of the best materials suited for the purpose. All parts subject to rubbing shall be of significantly different hardness to prevent galling and shall be sized to result in a maximum bearing stress at full load of 2,000 psi. The main shaft shall be replaceable without removing the torque unit housing and while the valve is in the line under pressure.

T. The manufacturer shall certify that the ball valves are capable of operating in continuous duty service under these pressures and flow conditions.

U. Each valve shall by hydrostatically tested and tested for bubble tightness after the operator has been mounted and adjusted. Copies of the hydrostatic and leakage test certification and certification of conformance shall be submitted to the Engineer prior to shipment.

V. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

2.02 BALL VALVES (SERVICE AIR)

A. Ball valves (service air) shall be manufactured by Apollo Ball Valve Division of Conbraco Industries, Inc., Pageland, SC., or equal. The body materials shall be cast bronze rated at 600 psi WOG, 150 psi saturated steam. Valves shall be tested by the manufacturer to MSS SP-72, 100 psi air under water, in the opened and closed position. The valve shall provide a port diameter equal to or exceeding the mating pipe size. Valves 2-1/2 inches in diameter and smaller shall have lever operators, unless otherwise specified herein or noted on the Drawings. Levers shall be cadmium plated steel covered with a vinyl grip and attached with a nut and have a hole for tagging purposes. The stem gland shall be adjustable and independent of the lever to compensate for wear. Bottom loaded stems shall be designed to be blow-out proof. The stuffing box seals and ball seats shall be composed of glass-reinforced TFE. The ball and stem shall be 316 stainless. Ball valves shall have NPT ends.

- END OF SECTION -

SECTION 15105

CHECK VALVES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

## PART 2 -- PRODUCTS

### 2.01 SWING CHECK VALVES (WATER SERVICE)

A. Unless otherwise specified, check valves 3-inches and less shall be bronze, Y-pattern, swing check valves of the regrinding type. Valves shall have a minimum 200 psi non-shock cold water pressure rating and shall be as manufactured by Jenkins Bros. Corp., Crane Company, or equal.

B. Check valves larger than 3-inches shall be cushioned swing check valves rated for a minimum working pressure of 200 psi and shall be of the "Shockless Swing-Check" type as manufactured by Golden Anderson, Cla-Val, APCO, Val-Matic, or equal.

C. Valve closure shall be controlled by an external weighted lever arm, the action of which is cushioned by a hydraulic oil or pneumatic cylinder. Counterweights and cushion cylinders shall be designed so that adjustments can be made in the field to minimize surge and to prevent backflow and hammering noises during actual service conditions. The hydraulic oil or pneumatic cushion system shall be completely self-contained.

D. Valve bodies, cover discs, levers, and disc arms shall be constructed of heavy cast iron or cast steel fully conforming to the latest revision of ASTM A-126 Class B or Class WCB, respectively. Valve ends shall be Standard American 125 pound flat-faced flanged, in accordance with ANSI B16.1. Each valve disc shall be suspended from a noncorrosive shaft which shall pass through a stuffing box and be connected on the outside of the valve to the cushion and counterweight mechanism.

E. Valve seating shall be rubber-to-metal designed for drop-tight shutoff. The body seat ring shall be made of bronze or stainless steel and the disc seat ring of 80 Durometer rubber. Body and disc seats shall be renewable.

F. With the exception of the valve body and seat, all parts in contact with water shall be manufactured from noncorrosive materials. Internal corrosive surfaces shall be shop painted with two coats of epoxy for corrosion resistance. Exterior surfaces shall be painted in accordance with the requirements of Section 09900, Painting.

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2.02 CHECK VALVES (PROCESS AIR)

A. Check valves (process air) shall be provided on the discharge of each of the new blower units. Check valves shall be as manufactured by APCO and shall be double-door type with cast iron bodies, ASTM A 126, Class B, and 125-pound standard flanged connections, or insert Type ANSI B16.34. Discs shall be ductile iron, electroless nickel coated, ASTM A 395, and shall be spring-loaded, normally closed, by means of two (2) 316 stainless steel springs which act independently, one on each of two hinged discs. Maximum spring deflection from neutral position for full open valve shall be 140. Valve seating shall be Butyl or Viton A, and shall provide a zero leakage at 5 to 25 psig at a work temperature of 225°F. Maximum pressure loss through check valves shall be:

| Air Flow (scfm) | Pressure Loss Through Valve (inches water column) |
|---|---|

- END OF SECTION -

SECTION 15108

GATE VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 GATE VALVES

A. All gate valves between 2 inches and less than 4 inches shall be iron body, bronze trimmed, wedge disc, and minimum 150 psi non-shock cold water pressure rating. Exposed valves shall be of the outside screw and yoke (OS&Y), ANSI B-16.1, 125 pound flanges and shall be as manufactured by the Crane Company, Jenkins Bros. Corp., or equal.

B. Valves less than 2 inches shall be of bronze body, rising stem, wedge disc and minimum 300 psi non-shock cold water pressure rating. Valves shall have screwed ends or as specified otherwise.

C. Gate valves 4 inches through 16 inches shall be of the non-rising stem design, shall fully comply with the requirements of AWWA C509 for resilient-seated gate valves and shall be the Metroseal 250 as manufactured by U.S. Pipe and Foundry Co., or equal by Mueller, Clow, or American Flow Control. Gate valves shall be designed for a minimum working pressure of 250 psi and a test pressure of 500 psi.

D. Gate valve body and bonnet shall be cast iron conforming to ASTM A126, Class B with resilient seat gate and O-ring seals. The gate shall be cast iron with a vulcanized rubber coating with no metal to metal contact when in the fully closed position and a smooth unobstructed waterway when in the fully opened position. Gate valves 18 inches and larger shall fully comply with the requirements of AWWA C500 and shall be double disc parallel seat with bypass and inside screw spur geared operator, unless otherwise specified or shown on the Drawings. Valves shall be manufactured by Mueller, Clow, U.S. Pipe and Foundry, or American Flow Control.

E. Valves shall be flanged mechanical joint as shown on the Drawings, with non-rising stems, and with a 2-inch square standard AWWA operating nuts unless otherwise shown on the Drawings or specified herein.

F. All internal ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

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2.02 KNIFE GATE VALES

A. Knife gate valves shall be cast iron conforming to ASTM A126, Class B with resilient ring seal seat. The gate shall be stainless steel with a beveled, knife-like edge. The knife gate valve shall be flanged in accordance with ANSI B-16.1, 125 pound flange with a handwheel operator as manufactured by DeZurik, or equal.

- END OF SECTION -

SECTION 15114

MISCELLANEOUS VALVES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

B. Valves intended for chemical service shall be constructed of materials suitable for the intended service.

## PART 2 -- PRODUCTS

### 2.01 GLOBE VALVES (SERVICE/COMPRESSED AIR)

A. Globe valves (service/compressed air) shall be bronze body and bonnet with brass stem and stainless steel regrindable disc plug. Valves shall be Jenkins Valve Fig. 546-P, Crane Co., or approved equal with minimum 300 psi non-shock cold water pressure rating and screwed ends.

### 2.02 SOLENOID VALVES

A. Three-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co., or approved equal, for 120V, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

B. Two-way solenoid valves shall be normally closed and shall open when the solenoid is energized, unless otherwise noted. The valve shall be of forged brass-body and bonnet with a BUNA "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi, and shall be as manufactured by ASCO Valves, Automatic Switch Co., or approved equal, for 120 volt, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight.

C. Four-way two-position solenoid valves shall be of the single coil type and shall be normally closed and shall open when the solenoid is energized (i.e. fail closed). The remainder of the four-way two-position solenoid valves shall be of the two coil type. Both coils shall be normally closed and each shall open independently when energized. The valve shall be of forged brass-body and bonnet with a Buna "N" diaphragm and screwed ends. The solenoid's internal parts shall be of 300 and 400 series stainless steel. The valve shall have a safe body working pressure of 125 psi and shall be as manufactured by ASCO Valves, Automatic Switch Co. or approved equal, for 120V, 60 Hz, single phase operation. Solenoid enclosure shall be NEMA 4 watertight. The solenoid valve shall be provided with a manual override.

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2.03 PRESSURE RELIEF, REDUCING AND REGULATING VALVES

A. Pressure relief valves 1 inch and under shall have bronze bodies and above 1 inch shall have cast iron bodies, bronze fitted with grey iron diaphragm base and straight chamber and phosphorus bronze diaphragm. The ratio of the diaphragm area to the seat area shall be adequate to overcome sticking. The seat disc shall be of non-corrodible, non-sticking material capable of withstanding extreme temperatures. Valves shall permit dismantling for repairs and cleaning without being removed from the line. Valves shall conform to the ASME Boiler Construction Code as approved by both the Underwriters Lab., and the National Board of Boiler Pressure Vessel Inspectors. All valves shall be designed for a minimum working pressure at least equal to the working pressure of the corresponding pipeline and shall have adjustment over a range of at least 20 percent above or below the required setting pressure of the installation.

B. Pressure relief valves (non-potable water service) shall be diaphragm activated, single seat, pilot operated and shall maintain a constant upstream pressure by relieving excess pressure. The valve shall be normally closed and shall open to maintain the required back pressure when the valve inlet pressure reaches the pilot control set point. The initial pilot control setting shall be 78 psi. The stem shall be stainless steel and shall be guided through the center for 100% of the stem travel. The main valve throttling plug shall be provided with V-port sections to insure precise control at low flow rates. All internal metal parts shall be bronze or stainless steel. The control pilot shall be direct acting, spring loaded, and adjustable with bronze body and stainless steel trim. The diaphragm and seat disc shall be BUNA-N. The valve shall be of the angle or globe pattern as shown on the Drawings and shall be fully repairable in the line. The pressure relief valve shall be the Model 428CP as manufactured by Bailey, Fresno, California, or approved equal.

C. Pressure reducing and regulating valves (water service) 1/2-inch and under shall be bronze and above 1/2-inch shall have cast iron bodies bronze fitted. Valves shall be constructed with full openings and capable of supplying a full flow of water at reduced pressure. Valves shall be so constructed that repairs can be made without removing the valves from the line. The valves shall be equipped with a sedimentation chamber and stainless steel or bronze strainer. Pressure reducing and regulating valves shall be the back pressure sustaining type and shall operate over a range at differential pressures from 5 to 120 psi. Reducing and regulating valves shall meet or exceed the requirements of ASSE 1003 (ANSI A112.26.2) and shall be Model 616R, as manufactured by Fisher Controls, WATTS Series 25 AUB, GA, or approved equal.

2.04 PRESSURE AIR RELEASE VALVE (POTABLE WATER ONLY)

A. The pressure air release valve shall be constructed of cast iron with stainless steel trim and stainless steel float, and all working parts shall be bronze, brass, stainless steel, or other corrosion resistant material. The valves shall be designed for a minimum working pressure of 150 psi and a test pressure of 300 psi. All valves shall be provided with "soft seating" material to provide drip-tight closure at 1 to 65 psig. All valves shall be provided with a vacuum check.

B. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium (NSF approved) epoxy for

corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

C. The pressure air release valve shall be the following types and models as manufactured by Cla-Val, APCO, Val-Matic, Crispin, M&H, Val Matic or equal.

D.

| Location | Size | PRV Discharge Capacity @ 2 psi | Crispin Model # | Connection |
|---|---|---|---|---|
| Raw Water Pump Discharge | 1 " | 45 SCFM | DL-10 | Screwed |

2.05 HOSE VALVES

A. Hose valves shall be 300 lbs. non-shock cold water angle or globe valves, Fig. 112/113 as manufactured by Jenkins Valve Co., or approved equal. Valves shall be bronze bodied with Buna-N or neoprene disc and bronze bonnet and packing nut. Valve stem, gland, and lock nut shall be brass. Valve shall be provided with 3 inch diameter malleable iron handwheel, cap and chain, and 3/4-inch or 1-inch (or 2 inch near flushing connections) hose connection outlet.

2.06 NEEDLE VALVES

A. Needle valves shall be bronze body and spindle with follower gland and shall be 400 psi, non-shock cold water needle valves, Figure 743-G as manufactured by Jenkins Bros., Corp., Crane Co. No. 88, or approved equal.

B. Needle valves (service air) shall be bronze body, with stainless steel stem. Valves shall be Jenkins Valve Fig. 741G, Crane Co. or approved equal and shall have minimum 400 psi non-shock cold water pressure rating and screwed ends.

2.07 PINCH VALVES

A. Pinch valves shall be of the full metal body mechanical pinch type with flanged joint ends on both body and rubber sleeve. Port areas shall be 100% of the full pipe area through the entire valve length. Flanges shall be of one size larger than pipeline size to allow extra thickness of rubber. Mating pipeline flanges shall be standard reducing flange with I.D. to exactly match valve I.D. All internal valve metal parts are to be completely protected by the rubber pinch tube. The rubber pinch tube shall be one piece construction with integral flanges drilled to ANSI 125# standard. The pinch tube shall also be Nylon reinforced with an exterior wrapping of 1/8" thick neoprene. Handwheel closing mechanism shall be double-acting and pinch the sleeve equally from two sides. The stem shall be non-rising and have a non-rising handwheel. There shall be no cast part in the operating mechanism. Each valve shall have flanges conforming to ANSI B16.1, Class 125 lb. Valves shall be Series "75 DW" as manufactured by Red Valve Co., Inc. or approved equal.

2.08 MUD VALVES

A. Mud valves shall be cast iron body with bronze stem, stem nut, disc ring, and seat ring. Bolts and nuts shall be corrosion resistant. Mud valve shall be flanged with non-rising stem. Mud valve shall be Model F-3075 as manufactured by Clow, or approved equal.

2.09 TELESCOPING VALVES

A. Telescoping valves shall be of the size shown on the Drawings. The valves shall be rising stem lift with stainless steel tube body material. All connecting bails and hardware shall be stainless steel. Minimum wall thickness for the tube shall be 1/8". At the point where the sliding tube enters the vertical stationary pipe a seal shall be effected by means of a wiper gasket retained by a stainless steel holding flange. The friction seal flange shall have a neoprene or Buna-N wiper gasket. The valves shall have two V-notched weirs located at 180 degrees to each other (maximum travel 36"). The valve lift mechanism shall be ball bearing supported with torque plate, mounted on offset type cast iron pedestal. Provide electric motor operator in weather-tight enclosure to be mounted on valve floorstand. The operator shall be suitable for the intended operation and sized for the telescoping valve that it is used with. The electric operator shall raise and lower the telescoping valve at a rate of 1 FPM. Provide pushbutton station for operation in stainless steel NEMA 4 enclosure. The operator shall have a manual hand crank that does not turn during electric operation. The motor drive shall be a Limitorque valve controller, or approved equal. Telescoping valves shall be as manufactured by Waterman Industries, Inc., or approved equal.

2.10 KINETIC COMBINATION AIR VALVES

A. Kinetic combination air valve assemblies shall be installed at all the locations specified herein or indicated on the Drawings and shall be installed complete with all appurtenant piping and valves as required for a complete and operable installation, and shall conform to the requirements of AWWA C512. The valve shall be of the kinetic design capable of exhausting air at up to sonic velocity without blowing shut.

B. Body and cover shall be ASTM A126 Class B cast iron with stainless steel floats and replaceable seats of Buna-N nor other suitable material. Internal linkage mechanism shall be 18-8 stainless steel. Plastic or bronze components are not acceptable. Air release orifice shall be suitable for 150 psi maximum working pressure.

C. Valves shall have a flanged inlet face.

D. Valves shall have a protective cowl installed on the outlet.

E. The valves shall be manufactured by GA Industries, Inc., Figure 945-C or Val-Matic.

F.

| Location | Quantity | Size | Discharge Capability @ 5 psi | Connection |
|---|---|---|---|---|
| Raw Water Pumps | 7 | 2” | 234 cfm | Screwed |
| High Service Pumps | 3 | 3” | 696 cfm | Screwed |
| Backwash Pumps | 2 | 4” | 1857 cfm | Flanged |

2.11 SURGE RELIEF VALVE

A. Surge Relief Valve shall consist of a main valve assembly and a pilot system, completely assembled and tested as a unit and ready for field installation.

B. Main Valve

1. Main valve body shall be angle style, constructed of high-strength cast iron conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125. The valve shall be “full-ported” with a flow area through the valve no less than the area of its normal pipe size.

2. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area and the area on the upper surface is greater than that of the underside. There shall be no diaphragms or springs in the main valve.

3. The valve piston shall be fully guided on its outside diameter and all guiding and sealing surfaces shall be bronze. To minimize the consequences of throttling, the throttling shall be by long, stationary vee-ports located downstream of the seat and not by the seat itself. Sawtooth attachments or other add-on devices are not permitted.

4. The valve shall be fully capable of operating in any position without the need of springs and shall not incorporate stems, stem guides or spokes in the waterway. A visual position indicator shall be provided.

5. The main valve shall be serviceable in the line through a single flanged cover which provides easy access to all internal components.

C. Pilot System

1. Provide a system of pilots and controls to enable the valve to perform the function listed below. All controls and control piping shall be non-corrosive and suitable for the working pressure.

2. System shall include a normally closed, direct-acting, diaphragm operated, spring loaded bronze pressure relief pilot. Pilot shall be easily field adjustable from near zero to a minimum of 10% above the factory setting. Controls shall include adjustable closing speed control, Y-strainer and pilot isolating valves.

D. The valve shall open when system pressure exceeds its pressure setting and throttle as necessary to limit system pressure to a preset maximum pressure. When pressure subsides below the preset maximum the valve shall close tight.

E. The valve shall be angle style as manufactured by GA Industries, Inc. CLA-VAL or approved equal. Manufacturer’s authorized representative shall be present at the jobsite for assistance during equipment start-up and to train Owner personnel in the operation, maintenance and troubleshooting of the equipment provided.

## 2.12 DIRECT SOLENOID ACTUATED AIR VALVE

A. Direct solenoid actuated air valves shall be mounted on a common base or a manifold block designed with common air supply line and exhaust line connections. The direct solenoid actuated air valves shall be a multi-purpose, heavy-duty 5-ported, 4-way, 3-position, spring-centered, double-solenoid with lapped spool and sleeve assembly design. Supply air operating pressure range shall be up to 150 psig. Standard voltage for direct solenoid actuation shall be 24 Vdc, 60 Hz. Each direct solenoid actuated valve shall be actuated by either a momentary or a maintained signal applied alternately to the solenoid coils. These signals shall be from the plant computer control system. Separate open and close signal shall be sent to the valve. Valve manual override shall not be required. When no signal is sent to the valve, all air ports of the valve shall be blocked. Stainless steel valve spool and sleeve shall be selected. Direct solenoid actuated valves shall be Numatics, Inc. "Mark Series".

## 2.13 BACKFLOW PREVENTER

A. Reduced Pressure Backflow Preventer shall be of the size shown on the Drawings, and shall be of the reduced pressure principle type in accordance with AWWA Standard 6506-78, with two (2) independent operating spring loaded check valves and one (1) spring loaded, diaphragm actuated, differential pressure relief valve shall be installed between the check valves. Backflow preventer shall be bronze body construction, with EPT rubber discs and Buna-N and nylon diaphragm. Screws and springs shall be of stainless steel. End connections shall be screwed, unless otherwise specified or shown on the Drawings. Reduced pressure backflow preventer installations shall include isolation valves and four test cocks, furnished as an assembly. For reduced pressure backflow preventers less than 2" the installation assembly also shall include a strainer. Isolation valves for reduced pressure backflow preventers shall be ball valves, except for sizes 2" and larger which shall be resilient seat gate valves. Test cocks shall be located as recommended by the manufacturer to facilitate functional testing of the assembly. The reduced pressure backflow preventer shall be as manufactured by Beeco Division, Hersey Products Inc., Aergap Model 6CM, WATTS 909, or approved equal.

## 2.14 VACUUM/ AIR RELEASE VALVES

A. Vacuum/pressure air release valve assemblies shall be installed at all the locations specified herein or indicated on the Drawings and shall be installed complete with all appurtenant piping and valves as required for a complete and operable installation. The valves shall be constructed of cast iron with stainless steel float, and all working parts shall be bronze, brass, stainless steel, or other corrosion resistant material. The valves shall be designed for a minimum working pressure of 150 psi and a test pressure of 300 psi. The valves shall include isolation valve and backflushing attachments which shall consist of blow-off valves, quick disconnect couplings, and a minimum of 5 feet of rubber hose suitable for backflushing without dismantling the valve. All air and vacuum valves shall be provided with "soft seating" material to provide drip tight closure at 1 to 65 psig. The exhaust from the valve shall be piped to a suitable disposal point. All valves 1-inch diameter and larger shall have a 1/4-inch min. diameter drain plug.

B. The pressure air release valves shall have a 2-inch (minimum) threaded connection. The pressure air release valves shall have a discharge capacity of 140 scfm, minimum, at a differential pressure range from 2 psi to 65 psi, and an orifice of 1/4-inch diameter, minimum.

C. All internal and external ferrous components and surfaces of the valves, with the exception of stainless steel and finished or bearing surfaces, shall be shop painted with two coats (10 mils min. dry film thickness) of the manufacturer's premium epoxy for corrosion resistance. Damaged surfaces shall be repaired in accordance with the manufacturer's recommendations.

D. The air and vacuum valves and pressure air release valves shall be similar to the following types and models as manufactured by the ValMatic. or equal.

E.

| Location | Size | Discg. Cap @ 2 psi | Intake Cap @ 5 psi | ARV/PRV Model # | Connection |
|---|---|---|---|---|---|
| Backwash Pump Discharge | 2" | 140 scfm | 200 scfm | #38 | Threaded |

- END OF SECTION -

SECTION 15115

PVC/CPVC VALVES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS OF CONSTRUCTION

A. Valves provided for chemical service shall be constructed of materials suitable for the intended service. PVC valves shall be provided in PVC piping and CPVC valves shall be provided in CPVC piping.

B. Valve bodies shall be constructed of Class 12454-B PVC or Class 23447-B CPVC.

C. Acceptable elastomer materials for each chemical service shall be as follows:

| **Chemical** | **Acceptable Elastomers** |
|---|---|
| Drain | EPDM, Viton, Teflon |
| Hydrofluosilicic Acid | EPDM, Teflon |
| Sodium Hypochlorite, 15% | Viton, Teflon |
| Water (NPW, PW) | EPDM, Viton, Teflon |

2.02 PVC/CPVC BALL VALVES

A. Ball valves shall have 125 psi minimum non-shock cold water pressure rating. Valves shall have integral unions with screwed ends or flanged ends as required and shall have removable handles. Valves shall be manufactured by Chemtrol Products Division of NIBCO, Inc., IPEX Industrial Thermoplastics, or equal.

B. Ball valves for sodium hypochlorite service shall be single-seal type valves. The ball shall be drilled by the valve manufacturer at the factory. The pressure rating shall be a minimum of 125 psi.

2.02 PVC/CPVC SWING CHECK VALVES

A. Swing check valves shall have an external lever and weight. Check valves shall have flanged ends. Valves shall be capable of top entry to facilitate cleaning and repair without removal from the line. Valve shall incorporate a single disc design. Check valves shall be as manufactured by ASAHI/AMERICA, or equal.

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2.03 PVC/CPVC BALL CHECK VALVES

A. Ball check valves shall have 150 psi minimum non-shock cold water pressure rating and integral union with screwed ends or as specified otherwise. Valves shall be as manufactured by Chemtrol Products Division of NIBCO, Inc., or equal.

2.04 PVC/CPVC DIAPHRAGM VALVES

A. Diaphragm valves shall have flanged ends and shall have a position indicator and adjustable travel stop. Diaphragm valves shall be similar to Type G, as manufactured by ASAHI/AMERICA, or equal.

2.03 PVC/CPVC BUTTERFLY VALVES

A. Butterfly valves shall be wafer style and shall have polypropylene discs. Butterfly valves shall provide bubble-tight seating, with stainless steel shaft and gear operator, and shall be as manufactured by ASAHI/AMERICA, or equal.

- END OF SECTION -

SECTION 15170

ELECTRIC MOTORS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish all materials, tools and equipment necessary for furnishing, installing, connecting, testing and placing into satisfactory operation all electric motors as shown on the Drawings and specified herein. All motors required for this Contract shall comply with this Section unless otherwise noted.

### 1.02 SUBMITTALS

A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

3. Special Tools List.

4. Proposed Testing Methods and Reports of Certified Shop and Field Tests.

B. Each submittal shall be identified by the applicable specification section.

### 1.03 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Individual shop drawings for electric motors shall be submitted in accordance with the procedures and requirements set forth in Section 01300, Submittals, unless submitted as a part of the shop drawings for the driven equipment.

D. Shop drawings for electric motors shall include motor data sheets, dimensioned drawings, wiring diagrams (space heaters, temperature devices, etc.) identifying electric characteristics and design, mechanical construction, manufacturer's name, type and pertinent specifications for the use intended, along with the name of the equipment to be driven. For motors rated 50 horsepower or more, submittal of motor data for acceptance shall include, as a minimum, the following:

a. Manufacturer's type and frame designation

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b. Horsepower rating

c. Time rating (per NEMA Standards)

d. Ambient temperature rating

e. Insulation system designation (see Item r. for full description)

f. RPM at rated load

g. Frequency

h. Number of phases

i. Rated-load amperes

j. Voltage

k. Code letter (starting KVA per horsepower)

l. Design letter for integral horsepower induction motors (per NEMA Standards)

m. Service factor

n. Temperature rise at full load and at service factor load

o. Efficiency at 1/4, 1/2, 3/4 and full load

p. Power factor at 1/4, 1/2, 3/4 and full load

q. Motor outline, dimensions and weight

r. Insulation system description

s. Horsepower required by connected machine at specified conditions (load curves) shall be supplied for all compressors, propeller and positive displacement pumps.

E. The foregoing data shall also be verified after manufacture and shall be included with the information to be furnished in the operation and maintenance manuals specified.

F. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are acceptable and shall be submitted.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Electric motors shall be manufactured by Reliance Electric Company; U.S. Motors Division, Emerson Electric Company; Toshiba Industrial and Power Systems, Inc.; Siemens Energy & Automation, Inc.; General Electric Company; or approved equal.

2.02 MATERIALS AND CONSTRUCTION

A. Motors shall be built in accordance with the latest standards of NEMA, including, but not limited to MG-1 and MG-2, IEEE, ANSI and to the requirements specified herein.

B. Type

1. Unless otherwise noted, motors specified herein shall be polyphase, squirrel cage, NEMA Design B, or single phase capacitor or repulsion start induction motors. Special equipment requiring a motor drive with unusual characteristics shall be equipped with a definite purpose motor to meet the necessary requirements.

2. Unless otherwise shown or specified, all motors 1/2 horsepower or larger shall be three- phase, 60 Hertz, NEMA Design B, squirrel cage induction motors designed for operation at 480 volts or greater as specified herein or shown on the Drawings.

3. Unless otherwise specified in the individual motor specification for the driven equipment, or as required by the dynamic characteristics of the load as determined by the manufacturer of the machine to be driven, all polyphase squirrel cage motors shall be designed to withstand the starting voltage shown on the Drawings and shall have torque and locked rotor current characteristics as specified for NEMA Design B motors.

4. All motors 2 horsepower and smaller shall have windings encapsulated with a flexible epoxy compound, insulated with a flexible epoxy compound, or insulated with the manufacturer's premium quality system which shall be subject to acceptance by the Engineer.

5. All motors above 2 horsepower shall have stator windings vacuum impregnated with a polyester insulation compound.

6. Unless otherwise noted, all motors smaller than 1/2 horsepower shall be standard single-phase capacitor start or repulsion start induction type designed for operation on 120 volts or 208 volts, 60 Hz alternating current. The motor shall deliver rated load without exceeding a 80 degrees C temperature rise while operating in a 40 degrees C ambient temperature. Small fan motors less than 1/4 HP may be split-phase or shaded pole type as standard with the drive. Shaded pole motors rated more than 1/4 horsepower will not be approved. Fractional horsepower motors shall be completely equipped with all necessary auxiliary components for starting

and labeled as "Thermally Protected". Insulation shall be Class B, except that submersible motors shall have epoxy encapsulation. Unless otherwise noted, the motors shall be totally enclosed. Small fan motors may be of the open type where they are suitably protected from moisture dripping and lint accumulation. Motors shall be provided with sealed ball bearings lubricated for 10 years normal use.

7. Where specified, vertical hollowshaft motors shall be designed to carry the motors', pumps', and associated equipment's full thrust. The motors shall be equipped with grease lubricated spherical roller thrust bearings and lower radial guide bearings. Vertical hollowshaft motors shall be fitted with nonreversing ratchet assemblies where specified. Vertical adjustment shall be provided by means of a lockable nut at the top of the shaft.

8. Vertical hollowshaft motors shall have adequate thrust bearings to carry all motor loads and any other operating equipment loads. Horizontal motors shall not be installed where subjected to external thrust loads except where special motor construction is approved by the Engineer.

9. All small motors in or around chemical unloading and chemical feed rooms shall be Totally Enclosed Fan Cooled (TEFC) motors.

C. Rating

1. Each motor shall develop ample torque for its required service through its acceleration range and throughout its rated load range. The rating of the motors offered shall in no case be less than the horsepower shown on the Drawings or elsewhere specified. It should be noted that the motor sizes indicated on the Drawings or as otherwise specified herein, are motor sizes required to operate the specific equipment which is specified. Higher rated motor sizes may be determined from the actual equipment submitted, approved, purchased, and installed. Overload protection, starters, disconnect switches, and other necessary equipment shall be furnished and installed for the actual motor sizes required at no additional cost.

2. Motor ratings shall be based on continuous operation in an ambient temperature. The maximum temperature rise for open and drip proof type motors shall not exceed 90 degrees C, and for totally enclosed type motors shall not exceed 80 degrees C.

D. Insulation

1. Insulation shall be as specified for each particular type or class of motor. The insulation system shall provide a high dielectric strength, long life covering for the windings which may be required to operate in a continually damp and chemically contaminated environment. The insulation shall be resistant to attack by moisture, acids, alkalies, abrasives, and mechanical and thermal shock. Leads shall be sealed with a non-wicking, non-hydroscopic insulation material.

2. Motor insulation resistance may be checked at any time after delivery to the job site or during the warranty period. Encapsulated motor stators may be subjected to insulation testing while completely submerged in water. Any motor not meeting the requirements specified herein will be rejected and shall be promptly replaced at no cost to the Owner.

3. Torque and locked rotor current characteristics for three phase motors shall be NEMA Design B. The locked rotor KVA/HP input at full voltage for 10 horsepower. motors and larger shall not exceed that permitted for Code Letter "J", except for specialized equipment requiring a motor drive with special definite characteristics.

4. Unless otherwise specified, non-inverter duty motors shall be furnished with a Class F insulation system and inverter duty motors shall be furnished with a Class H insulation system. In either case, temperature rise shall be limited to that for Class B insulation (80°C). Output torque and speed characteristics of each motor shall be suitable to operate the driven equipment through the full range of acceleration and operating load conditions without exceeding the nameplates current rating, and/or temperature rise.

E. Nameplates

1. The motor manufacturer's nameplates shall be engraved or stamped on stainless steel and fastened to the motor frame with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall include as a minimum, Items a through m as listed in Article 1.03 in addition to that required by NEMA standards. The nameplate shall be positioned so as to be readily visible for inspection in the completed machine.

F. Design

1. Motors shall be designed to accelerate and drive the connected equipment under all normal operating conditions without exceeding nameplate ratings.

2. Motors specified for operation with variable frequency drives shall be inverter duty and shall be designed to output 100 percent of nameplate horsepower under continuous duty service without exceeding the temperature rise specified herein when controlled by the actual drives furnished. Inverter duty motors shall be designed to operate down to 10% of full load speed without the need for a line-powered separate cooling fan.

3. Unless otherwise specified, electric motors shall be furnished with service factors in accordance with NEMA MG-1 as follows:

| **Type of Motor** | **Service Factor** |
|---|---|
| Non-inverter Duty | 1.15 |
| Inverter Duty | 1.0 |

4. Design selection with respect to the driven machine shall be such that the requirements do not exceed 85 percent of the motors' maximum rating modified by service factor, ambient temperature, enclosure, altitude and electrical service. The electrical service conditions shall be assumed to be 10 percent undervoltage, 5 percent underfrequency, and 3 percent voltage unbalance. Altitude shall be assumed to be the plant elevation plus 10 percent. Ambient temperature shall be assumed to be 95 degrees F in exterior locations, 104 degrees F (40 degrees C) in interior locations, and 122 degrees F (50 degrees C) within housings or enclosures; except where higher temperatures may be encountered within or on individual items of equipment. The applicable paragraphs of NEMA MG-1 shall be used in making the design selection.

5. Motors used with belt drives shall have sliding bases to provide for belt take up.

6. Terminal boxes shall be of sufficient size to accommodate the required quantity and size of conduits. Gasketed terminal boxes shall be furnished with all splash-proof and totally enclosed motors. NEMA ratings of the terminal boxes shall be suitable for the application. Motors located in hazardous locations shall be furnished with terminal boxes suitable for the specific Class, Division, and Group of the application. Terminal boxes shall be sized to accommodate accessory equipment such as motor differential current transformers, where specified.

7. Terminal boxes for horizontal motors shall be located on the left-hand side when viewing the motor from the drive end and shall be so designed that conduit entrance can be made from above, below, or either side of the terminal box.

8. Motors larger than 250hp shall be manufactured with the six stator coil leads wired to the motor junction box for application in a differential relay scheme. Current transformers shall be provided by the motor manufacturer and installed in the factory. All ground connections and current transformer connections shall be made in the factory.

G. Construction

1. Frames, mounting means, and shafts shall meet NEMA Standards for the horsepower, RPM, and enclosure selected. Enclosures shall be selected according to the degree of mechanical protection required and shall not be of aluminum construction. All motors shall have a manufacturer's standard shop machinery finish, consisting of a rust-resisting priming coat of zinc chromate and a finish coat of alkyd machinery enamel. Reference Section 09900, Painting.

2. Motors shall have cast iron frames and a heavy gauge steel terminal box, with neoprene gaskets between the frame and the box and between the box and its cover. A grounding lug(s) shall be provided inside the terminal box.

3. Motors weighing more than 50 pounds shall be equipped with at least one lifting eye. All hardware shall be corrosion resistant.

4. Motors located in hazardous locations as defined by the NEC shall be totally enclosed and suitable for the specific Class, Division, and Group of the application.

5. Motors located in Class I or II, Division 1 hazardous locations shall bear the U.L. label and shall be provided with a breather/drain approved for the hazardous location. The U.L. listed breather/drain shall prevent the entrance of contaminants while allowing moisture to drain out of the motor.

6. When located outdoors, or elsewhere if specified, motors shall be totally enclosed, non-ventilated (TENV) or totally enclosed, fan-cooled (TEFC) machines, unless otherwise noted. Totally enclosed motors shall be provided with two (2) 1/4 inch drain holes drilled through the bottom of the frame, which allows complete drainage of the frame. Where specified, TEFC motors controlled by a variable frequency drive shall be provided with a separately powered cooling fan motor that runs at 60HZ to

ensure proper cooling of the motor at low speeds. Cooling fan motor shall be suitable for 120VAC, single phase operation.

7. Unless otherwise specified in the equipment specifications, motors rated 100 horsepower or greater located outdoors, in unheated structures, in below grade areas, or as otherwise indicated, shall be furnished with space heaters and embedded motor winding high temperature switches with leads brought out of the motor terminal box. Space heaters shall be suitable for 120VAC operation and for a maximum surface temperature of less than 200 degrees C. Space heaters shall be of sufficient wattage to maintain the internal temperature of the motor at approximately 10 degrees C above the ambient temperature when the motor is not running.

8. Embedded motor winding temperature switches shall operate at temperatures well below the temperature rating of the motor winding insulation system. Motor winding temperature switches are not required where other temperature monitoring devices (e.g. RTD's) are required.

9. Unless otherwise specified in the equipment specifications, motors rated 200HP or greater that are controlled by a VFD shall be furnished with resistance thermal detectors (RTD's) embedded in the stator windings, two (2) per phase. RTD's shall be pre-wired to terminal blocks located in a separate terminal box as specified herein.

10. Unless otherwise specified in the equipment specifications, motors rated less than 200HP that are controlled by a VFD shall be furnished with motor winding high temperature switches embedded in the stator windings with the leads brought out to the motor terminal box.

11. If so specified and when located in indoor areas, which are heated and weatherproof, motors shall be open drip-proof machines. Ventilation openings shall be arranged to prevent the entrance of drops of liquid or solid particles at any angle from zero to 15 degrees downward from vertical.

12. Unless otherwise specified, or required, motors rated less than 200 horsepower shall be furnished with bearings of the grease lubricated, antifriction ball type with conveniently located grease fittings and drain plugs. A means of preventing bearings from becoming overgreased shall be provided. Bearings shall have a minimum B-10 life of 20,000 hours.

13. Rotors shall be statically and dynamically balanced. Rotor windings shall be one-piece cast aluminum. Where applicable, rotors shall be constructed with integral fins.

H. Power Factor and Efficiency

1. All motors, including vertical hollowshaft motors, in the range of 1-500 horsepower, inclusive, shall be designed specifically for energy efficiency and high power factor. The motor efficiency and power factor shall meet or exceed the values listed in the table below when the motors are tested in accordance with the NEMA preferred test method IEEE 112A, Method B, Dynamometer. Each motor shall meet the minimum

guaranteed efficiency value indicated in the table below. All tests shall be performed in accordance with the procedures contained in NEMA Standard MG1-12.58.

**TABLE 12-11**
**FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS**
**ENCLOSED MOTORS**

| | 2 POLE | | 4 POLE | | 6 POLE | | 8 POLE | |
|---|---|---|---|---|---|---|---|---|
| HP | Nominal Efficiency | Minimum Efficiency | Nominal Efficiency | Minimum Efficiency | Nominal Efficiency | Minimum Efficiency | Nominal Efficiency | Minimum Efficiency |
| 1 | 75.5 | 72 | 82.5 | 80 | 80 | 77 | 74 | 70 |
| 1.5 | 82.5 | 80 | 84 | 81.5 | 85.5 | 82.5 | 77 | 74 |
| 2 | 84 | 81.5 | 84 | 81.5 | 86.5 | 84 | 82.5 | 80 |
| 3 | 85.5 | 82.5 | 87.5 | 85.5 | 87.5 | 85.5 | 84 | 81.5 |
| 5 | 87.5 | 85.5 | 87.5 | 85.5 | 87.5 | 85.5 | 85.5 | 82.5 |
| 7.5 | 88.5 | 86.5 | 89.5 | 87.5 | 89.5 | 87.5 | 85.5 | 82.5 |
| 10 | 89.5 | 87.5 | 89.5 | 87.5 | 89.5 | 87.5 | 88.5 | 86.5 |
| 15 | 90.2 | 88.5 | 91 | 89.5 | 90.2 | 88.5 | 88.5 | 86.5 |
| 20 | 90.2 | 88.5 | 91 | 89.5 | 90.2 | 88.5 | 89.5 | 87.5 |
| 25 | 91 | 89.5 | 92.4 | 91 | 91.7 | 90.2 | 89.5 | 87.5 |
| 30 | 91 | 89.5 | 92.4 | 91 | 91.7 | 90.2 | 91 | 89.5 |
| 40 | 91.7 | 90.2 | 93 | 91.7 | 93 | 91.7 | 91 | 89.5 |
| 50 | 92.4 | 91 | 93 | 91.7 | 93 | 91.7 | 91.7 | 90.2 |
| 60 | 93 | 91.7 | 93.6 | 92.4 | 93.6 | 92.4 | 91.7 | 90.2 |
| 75 | 93 | 91.7 | 94.1 | 93 | 93.6 | 92.4 | 93 | 91.7 |
| 100 | 93.6 | 92.4 | 94.5 | 93.6 | 94.1 | 93 | 93 | 91.7 |
| 125 | 94.5 | 93.6 | 94.5 | 93.6 | 94.1 | 93 | 93.6 | 92.4 |
| 150 | 94.5 | 93.6 | 95 | 94.1 | 95 | 94.1 | 93.6 | 92.4 |
| 200 | 95 | 94.1 | 95 | 94.1 | 95 | 94.1 | 94.1 | 93 |
| 250 | 95.4 | 94.5 | 95 | 94.1 | 95 | 94.1 | 94.5 | 93.6 |
| 300 | 95.4 | 94.5 | 95.4 | 94s.5 | 95 | 94.1 | | |
| 350 | 95.4 | 94.5 | 95.4 | 94.5 | 95 | 94.1 | | |
| 400 | 95.4 | 94.5 | 95.4 | 94.5 | | | | |
| 450 | 95.4 | 94.5 | 95.4 | 94.5 | | | | |
| 500 | 95.4 | 94.5 | 95.8 | 95 | | | | |

**TABLE 12-12**
**FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS**
**RATED 600 VOLTS OR LESS (RANDOM WOUND)**
**OPEN MOTORS**

| | 2 POLE | | 4 POLE | | 6 POLE | |
|---|---|---|---|---|---|---|
| HP | Nominal Efficiency | Minimum Efficiency | Nominal Efficiency | Minimum Efficiency | Nominal Efficiency | Minimum Efficiency |
| 1 | 77 | 74 | 85.5 | 82.5 | 82.5 | 80 |
| 1.5 | 84 | 81.5 | 86.5 | 84 | 86.5 | 81.5 |
| 2 | 85.5 | 82.5 | 86.5 | 84 | 87.5 | 81.5 |
| 3 | 85.5 | 82.5 | 89.5 | 84 | 88.5 | 86.5 |
| 5 | 86.5 | 84 | 89.5 | 84 | 89.5 | 87.5 |
| 7.5 | 88.5 | 86.5 | 91 | 89.5 | 90.2 | 88.5 |
| 10 | 89.5 | 87.5 | 91.7 | 90.2 | 91.7 | 90.2 |
| 15 | 90.2 | 88.5 | 93 | 91.7 | 91.7 | 90.2 |
| 20 | 91 | 89.5 | 93 | 91.7 | 92.4 | 91 |
| 25 | 91.7 | 90.2 | 93.6 | 92.4 | 93 | 91.7 |
| 30 | 91.7 | 90.2 | 94.1 | 93 | 93.6 | 92.4 |
| 40 | 92.4 | 91 | 94.1 | 93 | 94.1 | 93 |
| 50 | 93 | 91.7 | 94.5 | 93.6 | 94.1 | 93 |
| 60 | 93.6 | 92.4 | 95 | 94.1 | 94.5 | 93.6 |
| 75 | 93.6 | 92.4 | 95 | 94.1 | 94.5 | 93.6 |
| 100 | 93.6 | 92.4 | 95.4 | 94.5 | 95 | 94.1 |
| 125 | 94.1 | 93 | 95.4 | 94.5 | 95 | 94.1 |
| 150 | 94.1 | 93 | 95.8 | 95 | 95.4 | 94.5 |
| 200 | 95 | 94.1 | 95.8 | 95 | 95.4 | 94.5 |
| 250 | 95 | 94.1 | 95.8 | 95 | 95.4 | 94.5 |
| 300 | 95.4 | 94.5 | 95.8 | 95 | 95.4 | 94.5 |
| 350 | 95.4 | 94.5 | 95.8 | 95 | 95.4 | 94.5 |
| 400 | 95.8 | 95 | 95.8 | 95 | 95.8 | 95 |
| 450 | 95.8 | 95 | 96.2 | 95.4 | 96.2 | 95.4 |
| 500 | 95.8 | 95 | 96.2 | 95.4 | 96.2 | 95.4 |

NOTES:

(1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.

(2) TEFC efficiencies apply to both horizontal and vertical motors.

2. Motors rated 50 horsepower or greater shall be individually tested at the factory before shipment, with a copy of test results provided for the Engineer, to assure compliance with the efficiency and power factor specifications.

I. Power Factor Correction

1. The power factor shall be corrected as necessary to achieve 85% (minimum) with capacitors sized and installed per manufacturer's recommendations. Capacitors shall be installed such that the motor shall not be damaged by overvoltage or excessive transient electrical torque. The capacitor(s) shall be connected as close as possible or directly to the motor terminals. Any power factor corrections shall not decrease the motor efficiency below the stated minimum requirement of this Specification. All power factor corrections shall be noted on the Shop Drawings submitted to the Engineer for approval. POWER FACTOR CORRECTION, TO ACHIEVE 85%, SHALL BE PROVIDED ON ALL MOTORS ABOVE 15 HORSEPOWER EXCEPT FOR THOSE MOTORS CONTROLLED BY VARIABLE FREQUENCY DRIVES (VFD'S).

2. When required, power factor correction capacitors shall be connected on the line side of <u>any</u> type of reduced voltage starting motor controller (e.g. RVAT, RVSS, Part-Winding, Wye-Delta, etc.).

2.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Each motor shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

<u>PART 3 -- EXECUTION</u>

3.01 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. All motors shall be shop tested and inspected in accordance with the equipment manufacturer's standard procedures. Shop tests for motors 100 horsepower and larger may be witnessed by the Owner. The manufacturer's testing and inspection procedures shall demonstrate that the equipment tested conforms to the requirements specified, all other applicable requirements, and shall be approved by the Engineer. At least 10 days notice shall be given the Engineer prior to tests and inspection dates.

b. In addition to the efficiency and power factor testing specified herein, each motor shall be tested to determine compliance with the applicable requirements of the IEEE, ANSI and NEMA. Tests shall be as follows:

(1) Motors less than 50 HP

(a) Each motor shall be subjected to a standard, short commercial test including the following:

i) Running current, no load

ii) Locked rotor current
iii) High potential
iv) Winding resistance
v) Bearing inspection

(2) Motors between 50 and 100 HP

(a) Each motor shall be subjected to the above tests and shall be furnished with certified test results.

(3) Motors larger than 100 HP

(a) Each motor shall be furnished with certified test results. Each motor shall be subjected to a complete test consisting of full load heat run, percent slip, running load current, locked rotor current, breakdown torque (calculated), starting torque, winding resistance, high potential, secondary current and voltage at collector rings (wound rotor), efficiencies at 100, 75 and 50 percent of full load, power factors at 100, 75 and 50 percent of full load and bearing inspection. Tests may be witnessed by the Engineer where specifically indicated.

(4) Test Reports

(a) All test results for motors over 100 horsepower shall be submitted to the Engineer for approval. Copies of witnessed test raw data shall be submitted to the Engineer immediately upon completion of such tests.

- END OF SECTION -

(EXHIBIT A)

| MOTOR TEST RECORD | | | | | |
|---|---|---|---|---|---|
| Motor Identification Remarks | Location | Specified Horsepower | Nameplate Horsepower | Nameplate Amperage (FLA) | Measured Amperage Under Normal Operating Conditions |
| | | | | | |

SECTION 15390

SCHEDULES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. Reference Section 15000, Basic Mechanical Requirements.

1.02 PIPING SYSTEM SCHEDULES

A. Piping requirements for this Section are outlined on the Drawings, and in the Piping System Schedule. In the absence of a specified test pressure, pipe shall be tested at a pressure 50 percent greater than the normal operating pressure as determined by the Design Builder or 10 psig, whichever is greater unless the Schedule indicates that no test is required.

B. If the pipe material is not shown on the Piping System Schedule or otherwise specified, the following materials shall be used:

| Pipe Size | Material | Type of Joint | Class/Design | Test Pressure |
|---|---|---|---|---|
| 4-in and larger | DIP | Flanged (Exposed)<br>Restrained (Buried) | 53<br>51 | (1) |
| Less than 4-in | PVC | Socket | Sch 80 | (1) |

(1) Test at 150 percent of normal operating pressure or 10 psi, whichever is greater.

C. Non-critical gravity lines such as drains, floor drains, roof drains, etc., do not typically require a pressure test.

1.03 VALVE SCHEDULES

A. Performance Affidavits shall be required for all valves listed in the valve schedule(s). Performance Affidavits shall be provided in accordance with Section 11000, Equipment General Provisions and Section 01300, Submittals. All valves shall be tagged by the manufacturer according to the control valve designations listed in the Schedule.

B. Valves not listed in the valve schedule(s) shall be manually operated, unless otherwise shown on the Drawings.

090705BR

## PIPING SYSTEM SCHEDULE

| EXTERIOR PIPING SCHEDULE | | | | | |
|---|---|---|---|---|---|
| PIPE IDENTIFICATION | MATERIAL | TYPE OF JOINT | CLASS/DESIGN | RESTRAINT SYSTEM DESIGN* PRESSURE | TEST PRESSURE |
| ASC | DIP | RESTRAINED (BURIED) FLANGED (EXPOSED) | CLASS 350 | 150 PSI | 150 PSI |
| AMS | CPVC (EXPOSED)** | SOCKET | SCH 80 | 150 PSI | 150 PSI |
| | BRAIDED PVC HOSE IN CASING PIPE (BURIED) | BARB WITH 316 SS CLAMPS | SEE SECTION 15008 | N/A | |
| BWS, BWW, FLW, FTW, BWTS | DIP | RESTRAINED | CLASS 350 | 150 PSI | 150 PSI |
| D | < 4" PVC | SOCKET | SCH 80 | N/A | 50 PSI |
| | > = 4" DIP | PUSH-ON | CLASS 350 | | |
| FW | DIP | RESTRAINED | CLASS 350 | 250 PSI | 250 PSI |
| NPW | < 4" PVC | SOCKET | SCH 80 | 150 PSI | 100 PSI |
| | > = 4" DIP | RESTRAINED/ PUSH-ON | CLASS 350 | | |
| OF | DIP | RESTRAINED | CLASS 350 | 20 PSI | 10 PSI |
| PW | <4" CPVC (EXPOSED)** < 4" PVC (BURIED) | SOCKET | SCH 80 | 150 PSI | 100 PSI |
| | < 4" COPPER** | SOLDERED | TYPE K (BURIED) TYPE L (EXPOSED) | | |
| | > = 4" DIP** | RESTRAINED | CLASS 350 | | |
| S | PVC | SOCKET | SCH 80 | 150 PSI | 150 PSI |
| SA | CARBON STEEL | THREADED | SCH 80 | N/A | 150 PSI |
| SAN | < 6" PVC | SOCKET | SCH 80 | N/A | 15 PSI |
| | > = 6" DIP | PUSH-ON | CLASS 350 | | |
| SPD | < 4" PVC | SOCKET | SCH 80 | 50 PSI | 100 PSI |
| | > = 4" DIP | PUSH-ON | CLASS 350 | | |
| V | PVC | SOCKET/FLANGED | SCH 80 | 100 PSI | 100 PSI |
| CASING PIPE FOR AMS, F, HC | PVC | SOCKET | SCH 40 | N/A | N/A |

* DESIGN PRESSURE SHALL BE USED TO DETERMINE THE SIZE, NUMBER, MATERIAL AND DIMENSIONS OF TABS AND THREADED-RODS FOR PIPING SPECIFIED OR SHOWN TO HAVE THREADED-RODS FOR THRUST RESTRAINT.

** PROVIDE HEAT TRACING AND INSULATION AS SPECIFIED IN DIVISION 15 ON ALL EXTERIOR EXPOSED PIPING INDICATED.

| INTERIOR PIPING SCHEDULE | | | | | |
|---|---|---|---|---|---|
| PIPE IDENTIFICATION | MATERIAL | TYPE OF JOINT | CLASS/DESIGN | RESTRAINT SYSTEM DESIGN* PRESSURE | TEST PRESSURE |
| BWS, BWW, FLW, FTW, BWTS | DIP | FLANGED | CLASS 350 | 150 PSI | 150 PSI |
| AMS, F, HC | PVC | SOCKET/FLANGED | SCH 80 | 150 PSI | 150 PSI |
| D | < 4" PVC | SOCKET | SCH 80 | N/A | 50 PSI |
| | > = 4" DIP | FLANGED | CLASS 350 | | |
| FW | DIP | FLANGED | CLASS 350 | 250 PSI | 250 PSI |
| NPW | < 4" PVC | SOCKET | SCH 80 | 150 PSI | 100 PSI |
| | >=4" DIP | FLANGED | CLASS 350 | | |
| PW | < 4" PVC | SOCKET | SCH 80 | 150 PSI | 100 PSI |
| | < 4" COPPER | SOLDERED | TYPE L | | |
| | >=4" DIP | FLANGED | CLASS 350 | | |
| S | PVC | SOCKET | SCH 80 | 150 PSI | 150 PSI |
| SA | CARBON STEEL | THREADED | SCH 80 | N/A | 150 PSI |
| SPD | < 4" PVC | SOCKET | SCH 80 | 50 PSI | 100 PSI |
| | > = 4" DIP | PUSH-ON | CLASS 350 | | |
| V | PVC | SOCKET/FLANGED | SCH 80 | 100 PSI | 100 PSI |

* DESIGN PRESSURE SHALL BE USED TO DETERMINE THE SIZE, NUMBER, MATERIAL AND DIMENSIONS OF TABS AND THREADED-RODS FOR PIPING SPECIFIED OR SHOWN TO HAVE THREADED-RODS FOR THRUST RESTRAINT.

| PIPING SYSTEM SCHEDULE DESIGNATIONS | | | | | |
|---|---|---|---|---|---|
| ASC | AIR SCOUR | FTW | FILTER TO WASTE | S | SAMPLE |
| BW | BACKWASH | FW | FINISHED WATER | SA | SERVICE AIR |
| BWS | BACKWASH SUPPLY | HC | SODIUM HYPOCHLORITE | SAN | SANITARY SEWER |
| BWW | BACKWASH WASTE | NPW | NON-POTABLE WATER | SPD | SUMP PUMP DRAIN |
| BWTS | BACKWASH TANK SUPPLY | OF | OVERFLOW | SW | SETTLED WATER |
| F | FLUORIDE | PW | POTABLE WATER | V | VENT |
| FLW | FILTERED WATER | RW | RAW WATER | D | DRAIN |

| ELECTRICALLY OPERATED VALVE SCHEDULE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CONTROL VALVE DESIGNATION | TYPE VALVE | TYPE OPERATOR | SIZE (INCHES) | FLOW (MGD) | MAXIMUM DIFF. PRESSURE (PSI) | CLASS | SERVICE | LOCATION |
| SW-01 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 1 INFLUENT | FILTER BLDG |
| FLW-01A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 1 EFFLUENT - ROF | FILTER BLDG |
| FLW-01B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 1 EFFLUENT | FILTER BLDG |
| FTW-01 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 1 FILTER TO WASTE | FILTER BLDG |
| BWS-01 | BFV | OPEN CLOSE | 30 | 14.4 | 15 | 150 | FILTER NO 1 BACKWASH | FILTER BLDG |
| BWW-01 | BFV | OPEN/CLOSE | 20 | 14.4 | | 150 | FILTER NO 1 BACKWASH WASTE | FILTER BLDG |
| ASC-01 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 1 AIR SCOUR | FILTER BLDG |
| SW-02 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 2 INFLUENT | FILTER BLDG |
| FLW-02A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 2 EFFLUENT - ROF | FILTER BLDG |
| FLW-02B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 2 EFFLUENT | FILTER BLDG |
| FTW-02 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 2 FILTER TO WASTE | FILTER BLDG |
| BWS-02 | BFV | OPEN CLOSE | 30 | 14.4 | 15 | 150 | FILTER NO 2 BACKWASH | FILTER BLDG |
| BWW-02 | BFV | OPEN/CLOSE | 20 | 14.4 | | 150 | FILTER NO 2 BACKWASH WASTE | FILTER BLDG |
| ASC-02 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 2 AIR SCOUR | FILTER BLDG |
| SW-03 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 3 INFLUENT | FILTER BLDG |
| FLW-03A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 3 EFFLUENT - ROF | FILTER BLDG |
| FLW-03B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 3 EFFLUENT | FILTER BLDG |
| FTW-03 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 3 FILTER TO WASTE | FILTER BLDG |
| BWS-03 | BFV | OPEN CLOSE | 30 | 14.4 | 15 | 150 | FILTER NO 3 BACKWASH | FILTER BLDG |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BWW-03 | BFV | OPEN/CLOSE | 20 | 14.4 | | 150 | FILTER NO 3 BACKWASH WASTE | FILTER BLDG |
| ASC-03 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 3 AIR SCOUR | FILTER BLDG |
| SW-04 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 4 INFLUENT | FILTER BLDG |
| FLW-04A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 4 EFFLUENT - ROF | FILTER BLDG |
| FLW-04B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 4 EFFLUENT | FILTER BLDG |
| FTW-04 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 4 FILTER TO WASTE | FILTER BLDG |
| BWS-04 | BFV | OPEN CLOSE | 30 | 14.4 | 15 | 150 | FILTER NO 4 BACKWASH | FILTER BLDG |
| BWW-04 | BFV | OPEN/CLOSE | 20 | 14.4 | | 150 | FILTER NO 4 BACKWASH WASTE | FILTER BLDG |
| ASC-04 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 4 AIR SCOUR | FILTER BLDG |
| SW-05 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 5 INFLUENT | FILTER BLDG |
| FLW-05A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 5 EFFLUENT - ROF | FILTER BLDG |
| FLW-05B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 5 EFFLUENT | FILTER BLDG |
| FTW-05 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 5 FILTER TO WASTE | FILTER BLDG |
| BWS-05 | BFV | OPEN CLOSE | 30 | 15.5 | 15 | 150 | FILTER NO 5 BACKWASH | FILTER BLDG |
| BWW-05 | BFV | OPEN/CLOSE | 20 | 15.5 | | 150 | FILTER NO 5 BACKWASH WASTE | FILTER BLDG |
| ASC-05 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 5 AIR SCOUR | FILTER BLDG |
| SW-06 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 6 INFLUENT | FILTER BLDG |
| FLW-06A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 6 EFFLUENT - ROF | FILTER BLDG |
| FLW-06B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 6 EFFLUENT | FILTER BLDG |
| FTW-06 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 6 FILTER TO WASTE | FILTER BLDG |
| BWS-06 | BFV | OPEN CLOSE | 30 | 16.6 | 16 | 150 | FILTER NO 6 BACKWASH | FILTER BLDG |
| BWW-06 | BFV | OPEN/CLOSE | 20 | 16.6 | | 150 | FILTER NO 6 BACKWASH WASTE | FILTER BLDG |
| ASC-06 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 6 AIR SCOUR | FILTER BLDG |
| SW-07 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 7 INFLUENT | FILTER BLDG |
| FLW-07A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 7 EFFLUENT - ROF | FILTER BLDG |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FLW-07B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 7 EFFLUENT | FILTER BLDG |
| FTW-07 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 7 FILTER TO WASTE | FILTER BLDG |
| BWS-07 | BFV | OPEN CLOSE | 30 | 16.6 | 16 | 150 | FILTER NO 7 BACKWASH | FILTER BLDG |
| BWW-07 | BFV | OPEN/CLOSE | 20 | 16.6 | | 150 | FILTER NO 7 BACKWASH WASTE | FILTER BLDG |
| ASC-07 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 7 AIR SCOUR | FILTER BLDG |
| SW-08 | BFV | OPEN/CLOSE | 20 | 3.6 | | 150 | FILTER NO 8 INFLUENT | FILTER BLDG |
| FLW-08A | BFV | MODULATING | 16 | 3.6 | | 150 | FILTER NO 8 EFFLUENT - ROF | FILTER BLDG |
| FLW-08B | BFV | OPEN/CLOSE | 16 | 3.6 | | 150 | FILTER NO 8 EFFLUENT | FILTER BLDG |
| FTW-08 | BFV | OPEN CLOSE | 16 | 3.6 | | 150 | FILTER NO 8 FILTER TO WASTE | FILTER BLDG |
| BWS-08 | BFV | OPEN CLOSE | 30 | 16.6 | 16 | 150 | FILTER NO 8 BACKWASH | FILTER BLDG |
| BWW-08 | BFV | OPEN/CLOSE | 20 | 16.6 | | 150 | FILTER NO 8 BACKWASH WASTE | FILTER BLDG |
| ASC-08 | BFV | OPEN/CLOSE | 12” | - | - | 150 | FILTER NO. 8 AIR SCOUR | FILTER BLDG |
| BWTS-01 | BFV | OPEN/CLOSE | 18” | 3.6 | 15 | 150 | CT BASIN CELL NO.1 | CHLORINE CONTACT BASIN |
| BWTS-02 | BFV | OPEN/CLOSE | 18” | 3.6 | 15 | 150 | CT BASIN CELL NO.2 | CHLORINE CONTACT BASIN |
| BWTS-03 | BFV | MODULATING | 18” | 3.6 | 15 | 150 | BACKWASH TANK | CHLORINE CONTACT BASIN |
| BWTS-04 | BFV | OPEN/CLOSE | 16” | 3.6 | 15 | 150 | BACKWASH TANK | CHLORINE CONTACT BASIN |

- END OF SECTION -

SECTION 15391

HEAT TRACING SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install heat tracing and insulation systems as shown on the Drawings and/or as required by Section 15390. All heat tracing components shall be supplied by the same manufacturer. The heat tracing and insulation system shall include but shall not be limited to self-regulating heater cables, grommet end termination kits, power connection kits, splice kits, NEMA 4X enclosed thermostats, piping insulation and jacket, and installation tape. The intent of this Specification is for the contractor to supply all appurtenances needed for a complete and fully operational system at each location that a heat tracing system is required. The heat tracing system supplier shall be completely responsible for the design of the system such that the entire system meets all aspects of this Specification and the system functions in the environment where it will be installed. All parameters of the system shall be sized and as recommended by the supplier.

B. The heat tracing system(s) shall be provided in accordance with the requirements of Section 15000.

C. Piping insulation and jacket shall be supplied with all heat traced piping and shall be in conformance with Section 15290. The thickness of the insulation shall be as stipulated in this Specification.

D. All air release valve piping that will remain constantly wet and that is installed outdoors shall be heat traced. All pressure gauge piping installed outdoors shall be heat traced and insulated.

E. The minimum design ambient temperature for the heat tracing system design shall be -40°F.

F. All the components of the heat tracing system shall be individually Underwriters Laboratory (UL) listed. The system as supplied shall conform to all applicable parts of the following:

1. National Fire Protection Association (NFPA)

2. National Electric Code (NEC)

3. Local and State Building Codes

011414BR

1.02 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Heat tracing system conductors and insulation for METAL piping shall be supplied in conformance with the following table:

| Heat Tracing Conductors and Insulation for Metal Piping | | | |
|---|---|---|---|
| | | Cable Heat Rating Watts per Foot | |
| Pipe Size (in) | Insulation Thickness (in) | Design Air Temperature -10°F | Design Air Temperature -40°F |
| ≤3/4 | 1 | 3 | 3 |
| 1 | 1 | 3 | 5 |
| 1-1/4 | 1 | 3 | 5 |
| 1-1/2 | 1 | 3 | 5 |
| 2 | 1 | 3 | 5 |
| 2-1/2 | 1 | 3 | 5 |
| 3 | 1-1/2 | 3 | 5 |
| 4 | 1-1/2 | 5 | 8 |
| 6 | 2 | 5 | 8 |
| 8 | 2 | 5 | 8 |
| 10 | 2 | 8 | 10(1) |
| 12 | 2 | 8 | 10(1) |

(1) Two conductors shall be provided and shall be placed on top of and under the pipe.

B. Heat tracing system conductors and insulation for nonmetallic piping shall be supplied in conformance with the following table:

| Heat Tracing Conductors and Insulation for Nonmetallic Piping | | | |
|---|---|---|---|
| | | Cable Heat Rating Watts per Foot | |
| Pipe Size (in) | Insulation Thickness (in) | Ambient Air Temperature -10°F | Ambient Air Temperature -40°F |
| ≤3/4 | 1 | 3 | 3 |
| 1 | 1 | 3 | 5 |
| 1-1/4 | 1 | 3 | 5 |
| 1-1/2 | 1 | 3 | 5 |
| 2 | 1 | 3 | 5 |
| 2-1/2 | 1 | 5 | 8 |
| 3 | 1-1/2 | 3 | 8 |
| 4 | 1-1/2 | 5 | 8 |
| 6 | 2 | 5 | 8 |
| 8 | 2 | 8 | 10 |
| 10 | 2 | 8(2) | (1) |
| 12 | 2 | 8(2) | (1) |

(1) Consult the heat tracing system manufacturer for the cable rating and the number of passes for each pipe.
(2) Two conductors shall be provided and shall be placed on top of and under the pipe.

1.03 SUBMITTALS

A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to the submittal requirements specified in Section 01300:

1. Submittal data on all components of the heat trace system and any other data recommended by the manufacturer

2. Installation and maintenance instructions

3. List of replacement parts for the entire system in table format

4. Bill of materials list of the system as supplied in table format

B. Operation and maintenance manual shall be submitted in accordance with Sections 01300, 11000 and 15000.

## PART 2 -- PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Each heat trace system shall be supplied by Thermon Manufacturing Company, Raychem Corporation, or Chromalox. All system components shall be supplied by a single manufacturer.

### 2.02 MATERIALS

A. The self regulating heater cable assembly shall consist of two parallel copper bus wires, minimum size 16 AWG, connected through a semi-conductive heating matrix. This heating element shall be covered with a cross-linked polyolefin insulation jacket. This insulation shall be covered by a tinned copper braid and then covered with a fluoropolymer insulating jacket. All heat cables shall be rated for 120 VAC. The heating cable shall be suitable for installation on metallic and nonmetallic pipe. All heating cable shall be properly marked by the manufactures number or nomenclature for ease of future maintenance. Cable shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations where cable is to be installed in hazardous locations.

B. Each heat tracing circuit shall be supplied with a power connection and end seal kit. Each end seal kit shall include a lighted end termination kit Chromalox model UESL or equal. It shall be the Contractor’s responsibility to make sure that no circuit in the system be longer than as recommended by the heat tracing system manufacturer. All terminations, splices, junctions and tees in the circuit shall be made using manufacturer recommended and supplied kits. Junction boxes shall be provided where required for access to all circuit appurtenances.

C. Flexible heater elements shall be provided where indicated on the Drawings to protect pumps and other equipment. The flexible heater shall be 3 inches wide by 40 inches long and shall consist of a heater element encapsulated in silicone rubber. The silicone rubber shall be rated for a temperature range of -80°F to 390°F. The flexible heater shall be designed with eyelets in the ends and edges as required for mounting on the pump using manufacturer supplied silicone straps. The flexible heater shall be rated for 120 VAC and 600 watts of heat output. The flexible heater shall be supplied with a preset thermostat which will energize the flexible heater when the ambient temperature reaches 40°F and shut down the heater when the ambient temperature reaches 50°F. The flexible heater shall be model SL-N as manufactured by Chromalox or equal.

2.03 ELECTRICAL AND CONTROL REQUIREMENTS

A. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat for each circuit shall be an adjustable ambient sensing thermostat designed for controlling the heating cable to provide freeze protection of pipes. The thermostat shall have an adjustable range of 15°F to 140°F. The enclosure for the thermostat shall be NEMA 4X. The Thermostat shall be rated to match the voltage of the heating cable and shall have a switch rating of 20 amps (minimum). Thermostat shall be suitable for use in Class 1 (Division 1 and 2) or Class 2 (Division 1 and 2) hazardous locations, and shall be provided where thermostat is shown to be installed in Class 1 Division 1 hazardous locations.

B. A thermostat shall be furnished and installed for each heat trace circuit. The thermostat shall have LED indication of set point, process temperature, high temperature alarm, low temperature alarm and RTD failure. The thermostat shall be housed in a NEMA 4X enclosure and shall suitable for use in a Class 1 Division 2 Location. The thermostat shall be UL listed. The Thermostat shall be rated to match the voltage of the heating cable with a switch rating of 30 amps (minimum). A common alarm contact shall be provided for remote indication of alarm status. The thermostat shall be Chromalox model DTS or equal. This thermostat shall be provided for all locations except for Class 1 Division 1 locations.

2.04 SPARE PARTS

A. Spare parts shall be provided in accordance with Section 11000 and shall include the following:

1. 100 feet of self-regulating cable for each cable wattage provided for the system(s)

2. One (1) spare ambient thermostat controller for each heat tracing system

3. One (1) spare ambient temperature RTD

4. Two (2) each of the following: cable termination kits, cable splice kits and cable tee kits

PART 3 -- EXECUTION

3.01 MANUFACTURER'S FIELD SERVICES

A. The services of a qualified manufacturer's technical representative shall be provided in accordance with Section 11000 and shall include the following site visits:

| **Service** | **Number of Trips** | **Number of Days/Trip** |
|---|---|---|
| Installation and Testing | 1 | 1 |
| Startup and Training | 1 | 1 |

3.02 INSTALLATION

A. The installation of all heat tracing and insulation components shall conform to all instructions and requirements recommended by the heat tracing system manufacturer. All installation and terminations shall conform to the National Electric Code.

B. All piping shall be pressure tested prior to installation of any heat tracing or insulation components. Thermal insulation shall only be installed when all heat tracing components are in place and satisfactorily tested as specified herein. Once tested, the insulation shall be installed immediately to prevent damage to the heat tracing system components.

C. No insulation shall be installed using staples. Insulation jackets shall be installed as recommended by the insulation system supplier such that no damage is done to the heat tracing system components.

D. The installation of heat tracing cable on nonmetallic pipe shall be done in strict conformance with the heat tracing manufacturer's recommendations. Requirements shall include heat shielding tape or wrap as recommended by the heat tracing manufacturer

E. Contractor shall install weather proofing for all outdoor piping. The field applied jacket with moisture barrier shall be slipped around pipe into preformed 2-lock position. Butt next jacket section adjacent to previous section leaving 3/8 inch gap. Place preformed 2 inch butt strap with sealant over the seam and secure with 1/2 inch aluminum band and wing seal. Contractor shall install preformed fittings identical in composition to pipe jacketing at all fittings

F. The Contractor shall insure that surfaces of pipes, valves, heat tracing, and fittings are clean and dry prior to installation of insulation. Insulation shall be installed so as to make surfaces smooth, even, and substantially flush with the adjacent insulation. The Contractor shall follow the manufacturer's application instructions for the materials used

G. A label shall be installed on the piping insulation jacket every 15 feet and readily visible from ground level: ELECTRIC HEAT TRACING: CAUTION

3.03 FIELD TESTING

A. All heating cable shall be tested using a megohmeter (megger) between the heating cable bus wires and the metallic ground braid. A 2,500 VDC megger test is required and the minimum acceptable resistance value shall be 20 megaohms regardless of the circuit length. Any cables found to be less than this value shall be replaced at no additional cost to the Owner. The megger tests shall be performed as follows:

1. After installation of the cable and all fabrication kits but prior to installing any of the insulation system components.

2. After installation of the insulation system components but prior to energizing the cables.

3. All test reading for each megger test shall be recorded by the installer and submitted with the maintenance instructions.

- END OF SECTION -

SECTION 15800

HEATING, VENTILATING AND AIR CONDITIONING

## PART 1 - GENERAL

### 1.01 RELATED DOCUMENTS

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

B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

### 1.02 SUMMARY

A. The Contractor shall furnish all labor, equipment and material for the complete installation of the air conditioning system as indicated on the Drawings and specified herein.

B. Heating, Ventilating and Air Conditioning systems shall be furnished and installed to operate as a system. The Contractor shall coordinate all requirements between manufacturers to insure unit responsibility and compatibility of the systems.

C. Work Included Under Other Sections:

1. 480V, 3-phase power wiring and conduit under Division 16, Electrical.

2. Motor starters under Division 16, Electrical, unless factory mounted and wired by equipment manufacturer.

3. 120V, 1-phase wiring and conduit to Control Panels and motorized dampers under Division 16, Electrical. Control wiring and conduit from Control Panels to field devices and equipment shall be provided by Automatic Temperature Control Contractor.

### 1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work or other mechanical and air conditioning work required, all in accordance with the requirements of Section 01300, Submittals.

B. The Contractor **shall not combine submittals** of differing equipment types under the same submittal transmittal number. Each type of equipment (Ex. Ductwork vs. Duct Insulation) shall have its unique transmittal. Engineer will reject any submittals that have been combined into a single binder.

C. Data to be submitted shall include but not be limited to:

1. Catalog data consisting of specifications, illustrations and a parts schedule that identifies the materials to be used for the various parts and accessories. The illustrations shall be in sufficient detail to serve as a guide for assembly and disassembly.

2. Complete assembly and installation drawings with clearly marked dimensions. This information shall be in sufficient detail to serve as a guide for assembly and disassembly and for ordering parts.

3. Weight of all component parts and assembled weight.

4. Electrical characteristics and wiring diagrams.

5. Sample data sheet of equipment nameplate(s) including information contained thereon.

6. Insulation materials, coating, jackets, detail density, thermal conductivity and thickness of all insulation materials to be furnished.

7. Details of special fasteners and accessories.

8. Type of adhesives, binders, joint cement, mastics.

9. Proposed insulation procedures and installation methods.

10. Spare parts list.

D. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of the results of all certified shop tests.

E. The Contractor shall obtain from the manufacturer and submit to the Engineer copies of certified letters of compliance in accordance with the Specifications.

F. The Contractor shall submit operation and maintenance manual in accordance with the procedures and requirements set forth in the General Conditions and Division 1. Operation and Maintenance Manuals shall be submitted for all equipment.

1. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

2. Equipment capacity (input and output).

3. Complete written narrative of how each system is intended to operate.

4. System control maintenance and calibration information, including wiring diagrams, schematics, and control sequence of operation descriptions. Desired or field determined set points shall be recorded on control drawings, at control devices, or, for digital control systems, in programming comments.

5. In addition to a full set of manuals with closeout documentation, each unit shall ship with its own manual in a watertight enclosure.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to the Project Site under the provisions of Division 1.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

D. Protect openings in casing and seal them with plastic wrap to keep dirt and debris. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.05 EXTRA MATERIALS

A. Provide one additional set of specified fan belts, sheaves, and filters for each unit, packaged for storage. Tag products to identify associated unit.

1.06 SCHEDULES ON DRAWINGS

A. In general, all capacities of equipment and motor and starter characteristics are shown in schedules on the Drawings. Reference shall be made to the schedules for such information. The capacities shown are minimum capacities. Variations in capacities of the scheduled equipment supplied under this Contract will be permitted only with the written direction of the Engineer.

B. Motors and wheel diameters shown on the schedules are the minimum. If a larger wheel diameter or horsepower is required, it shall be so quoted and noted.

1.07 MANUFACTURER'S INSTRUCTIONS

A. Installation of all equipment shall be in accordance with manufacturer's data.

B. All changes from the installation procedures in manufacturers' data shall be submitted for approval in accordance with the requirements for shop drawings.

C. Keep all manufacturers' data provided in a secure manner at the job site at all times. Catalog and index this data for convenient reference.

D. Manufacturers' data shall be available for the information of the Owner, Engineer, and the use of other trades.

E. Turn over all data to the Owner through the Owner's representative at completion of the Work and final testing.

F. Submit all instruction books and manuals in accordance with Division 1.

1.08 CODES, PERMITS AND STANDARDS

A. The Contractor shall obtain and pay for all permits (unless specifically excluded under Division 1 requirements) and shall comply with all laws and codes that apply to the Work.

B. The Contractor shall be responsible for all added expense due to his choice of equipment, materials or construction methods.

C. All work and materials shall be in full accordance with the latest State rules and regulations or publications including those of the State Fire Marshall, the Kentucky Mechanical and Energy Codes, and all local codes. Nothing in the Plans and/or Specifications shall be construed to permit work not conforming to the above codes, rules and regulations.

D. All equipment, materials and installations shall conform to the requirements of the most recent edition with latest revisions, supplements and amendments of the following, as applicable:

1. Air Diffusion Council (ADC)

2. Air Moving and Conditioning Association (AMCA)

3. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE)

4. American National Standards Institute (ANSI)

5. American Society for Testing and Materials (ASTM)

6. American Society of Mechanical Engineers (ASME)

7. Factory Mutual (FM)

8. National Electric Code (NEC)

9. NFPA 90A Air Conditioning and Ventilation Systems 2009 edition

10. NFPA 820 Standard for Fire Protection in Wastewater Treatment and Collection Facilities 2008 edition

11. Occupational Safety and Health Standards (OSHA)

12. Sheet Metal & Air Conditioning Contractors National Association (SMACNA)

13. State and local codes, ordinances and statutes

14. Underwriters Laboratories (UL)

15. Others as designated in the specifications.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum five (5) years documented experience, who issues complete catalog data on total product.

B. The Manufacturer of the equipment shall provide documentation supporting compliance with ISO-9000:2000 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the manufacturer shall contain the ISO-9000:2000 Certification Mark from the applicable registrar.

C. All material and equipment shall be the latest design, new, not deteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such material and equipment.

D. When two or more units of the same class of material or equipment are required, they shall be products of a single manufacturer.

E. All work shall be performed in a neat and workmanlike manner by workers skilled in their respective trades, and all materials and equipment shall be installed as recommended

by the manufacturers and in accordance with specified codes and standards.

F. Touch up and/or repaint to match original factory finishes for all finished or painted equipment and materials which are scratched or marred during shipment or installation.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. Each item of equipment shall be furnished and installed complete with all supports, mounting frames, duct work, piping, louvers, panels, grilles, electric drive units and controls, mechanical equipment, electrical work, insulation and appurtenances ready for operation.

B. All equipment and appurtenances shall be anchored or connected to supporting members as specified or as indicated on the Plans.

C. All mechanisms or parts shall be amply proportioned for the stresses which may occur during operation or for any other stresses which may occur during fabrication and erection. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials and shall be interchangeable. All equipment shall be of the manufacturer's top line, industrial commercial grade.

D. The Contractor shall ascertain that all chassis, shafts, and openings are correctly located otherwise he shall cut all new openings required at his own expense. Cutting of new openings shall be coordinated with other trades. Proposed new cutting shall be submitted to the Engineer for review and acceptance prior to cutting.

E. The Plans shall be taken as diagrammatic. The Contractor shall check the Structural Plans and sections for detail dimensions and clearances. Sizes of ducts and their locations are indicated, but not every offset, fitting, or structural obstruction is shown.

F. Alignment of ducts may be varied where necessary to account for slight architectural changes or to avoid conflict with the Work of other trades without additional expense to the Owner.

G. All supports required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided, unless specifically noted otherwise. Equipment shall be supported on spring type vibration isolators.

### 2.02 CENTRIFUGAL ROOF AND WALL EXHAUST FANS - ALUMINUM

A. Product and Manufacturer: Provide product(s) of one of the following:

1. Aerovent.
2. Greenheck (Basis of Design)
3. Loren Cook
4. Hartzel.
5. Or Approved Equal.

B. Wall-mounted centrifugal exhaust fan assembly (as shown on drawings) with manufacturer's wall flange mounting kit as required. Single-width single-inlet (SWSI).

C. Aluminum centrifugal wheel with single-thickness non-overloading backward-inclined blades attached to rim and back plate. Assembly keyed and locked to shaft.

D. Drive:

1. Steel shaft turned, ground, and polished; with keyway and protective coating of lubricating oil.

2. Shaft selected for first critical speed at least 125% of maximum speed.

3. Shaft mounted on regreasable pillow block ball or roller bearings with L50 life of at least 200,000 hours.

4. Lubrication lines with grease fittings extended outside housing.

5. Belt drive sized for minimum 150% of motor power rating. Oil and grease resistant, non-static belts.

6. Adjustable cast iron pulleys keyed and locked to shafts.

E. TEFC Motors shall be protected and cooled from outside the unit by forced ventilation. Drive shaft mounted on regreasable pillow block ball or roller bearings with L50 life of at least 200,000 hours.

F. Housing: Aluminum base panel with integral spun venturi inlet and welded curb cap corners; minimum 0.051-inch thick (16 gage).

G. Spun aluminum discharge wind band, motor compartment cover, and motor compartment cap; minimum 0.051-inch thick (16 gage). Rolled bead edges. Quick release latches on motor compartment cap. Motor compartment separated from exhaust air and ventilated with air drawn from outdoors.

H. Wind band arranged for down blast or up blast discharge as indicated. Drain for upblast wind band.

I. Gravity-actuated back draft dampers in roof curb with aluminum blades and frame, blade edge seals, pivot pins, and steel or aluminum linkage.

J. Aluminum 0.5-inch mesh bird screen.

K. Conduit chase from base panel into motor compartment.

2.03 EXTRUDED ALUMINUM LOUVERS

A. Subject to compliance with the Specifications, provide products manufactured by the following:

1. Airolite Company, Marietta, Ohio

2. Greenheck

3. Ruskin, Philips Industries, Inc.

B. Frame: Extruded aluminum 6063-T5 alloy, extruded within commercial tolerances and free of defects, 0.125 inches thick with reinforcing bosses. All corners of frames shall be reinforced and welded.

C. Blades:

1. Fixed blades shall be extruded aluminum 6063-T5 alloy, 0.080 nominal wall thickness.

2. Adjustable blades shall be extruded aluminum 6063-T5 alloy, 0.125 nominal wall thickness, drainable.

D. Hardware and fasteners shall be of Type 316 stainless steel placed through nylon bushings.

E. The louvers shall be architectural style, combination drainable type with operable units and fixed blade units.

F. The stationary blades and adjustable blades shall be contained within a single 6-inch deep louver frame. Adjustable section shall include low leakage blades and jamb seals.

G. Provide rain gutter in each fixed blade and downspouts in frame jambs and mullions.

H. Louver and damper assemblies which are to be placed in openings exceeding 5 feet in width shall have slidable interlocked heavy gauge extruded aluminum mullions at mid span of integral tongue and groove construction.

I. Bird screen shall be 1/2-inch square aluminum mesh PVC coated, placed in removable 0.080-inch thick folded aluminum frames.

J. Coordinate louver sizes and free area requirements with the HVAC work and architectural elevations.

K. Published performance ratings and free area shall be based on testing in accordance with AMCA 511. Louver performance shall be AMCA certified and carry the AMCA seal.

L. Performance Requirements:

1. Free Area: Not less than 7.0 sq. ft. for 48-inch-wide by 48-inch-high louver.

2. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area velocity.

3. Wind-Driven Rain Performance: Maximum of 0.01 ounces per square foot of free area at 680 feet per minute free area velocity when tested for 15 minutes.

4. Design Wind Load: Incorporate structural supports required to withstand wind loads of up to 20 pounds per square foot force or local code, whichever is more stringent.

M. Extruded aluminum louvers, damper frames and blades to receive Kynar 500, finish in accordance with the AAMA Specification 605.2. Color shall be selected by Owner from manufacturer's full range of colors.

1. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.

N. Damper Actuator

1. Manufacturer

a. Belimo

b. Honeywell

c. Siemens

d. Or approved equal

2. Close coupled 120 VAC with integral limit switch rated for a minimum of 90 in-pounds torque, power open, spring return

2.04 METAL DUCTWORK

A. The Contractor shall furnish and install the metal ductwork as shown on the Contract Drawings, as specified, and reasonably implied for a complete first class job. It is not the intention of the Contract Drawings to show all offsets, bends and fittings, which may be required. All such devices required for complete operation of the system shall be provided.

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. All ducts shall be made reasonably tight throughout and shall have no openings other than those required for the proper operation and maintenance of the systems.

E. **Seal and Pressure Class:** Construct and seal ducts according to the following SMACNA classes:

1. Unless otherwise noted on drawings or specified elsewhere, all ducts shall be constructed to Static Pressure Class from Negative 2-Inches wg (500 Pa) Through Positive 2-Inches wg (500 Pa): Seal class C.

F. Metal ductwork shall be constructed to minimum thicknesses and reinforcement per SMACNA guidelines. All supports and hardware shall be constructed of the same material as the duct (except for aluminum duct). Ductwork shall be connected by mechanical joining system manufactured by Ductmate Industries, Inc, or approved equal.

G. Changes in size of ducts shall be by means of a taper transformation piece, the included angle of the taper being not more than 30 degrees. All duct work joints shall be sealed.

H. The weight of material used for ducts and stiffeners, the fabrication methods, crossbreaking of flat duct surfaces, and assembling of the ductwork shall conform to the Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems published by the Sheet Metal and Air Conditioning Contractors National Association, Inc. Beaded duct construction shall not be used.

I. Suitable access doors shall be located in ducts for maintenance of dampers of equipment not otherwise accessible.

J. Sheet-metal duct connections to masonry or sheet metal openings shall be airtight.

1. Where indicated on the Contract Drawings, or where necessitated by physical conditions, duct turns shall be installed. Duct turns or turning vanes shall be of acceptable air-foil design.

2.05 NAME PLATES

A. White laminated phenolic plastic with minimum 3/16 inch high black engravings if viewing distance is less than 24 inches, 1/2 inch high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances.

B. Nameplates shall be affixed with weatherproof adhesive.

C. Nameplates shall be provided at all thermostats, control switches, panels, or any other device providing information on equipment being controlled. Name plates shall be provided on all HVAC equipment matching equipment scheduled identification numbering.

D. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color codes:

1. Yellow/Green: Supply air

2. Blue: Exhaust, outside, return and mixed air

3. Nomenclature: Include the following:

a. Direction of air flow.

b. Duct service (supply, return, exhaust, etc.)

2.06 GASKETS AND CONNECTORS

A. Provide new gaskets wherever gasketed mating equipment items or pipe connections have been dismantled. Gaskets shall be in accordance with manufacturer's recommendations.

B. Replace all assembly bolts, studs, nuts and fasteners of any kind which are bent, flattened, corroded or have their threads, heads or slots damaged.

C. Furnish all bolts, studs, nuts and fasteners for make up of all connections to equipment and replace any of these items damaged in storage, shipment or moving.

PART 3 - EXECUTION

3.01 INSTALLATION OF HVAC UNITS AND EQUIPMENT

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Install units on vibration isolators, where fans are not internally isolated.

D. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation of the Owner's representative(s).

E. Provide the minimum access space for maintenance of individual components such as fans, filters, coils, humidifiers, etc., as scheduled or shown on the Drawings. Arrange these components in a manner that allows for ease of replacement.

F. Arrange fans and surrounding components in such a way that poor fan performance does not result.

3.02 LOUVER INSTALLATION

A. Anchor louver frames using stainless steel bolts into holes drilled and tapped in channel or angle sub frames and suspended lintels, or with strap anchors to masonry in accordance with the manufacturer's approved directions.

B. Isolate aluminum from contact with masonry or dissimilar metals with heavy coat of bituminous paint or neoprene gaskets.

C. Mount bird screens on inside face with clips, machine screwed into frames.

D. All frames shall be installed with aluminum (or compatible) screws, bolts, anchors, etc., in such a manner that the frames are removable.

3.03 HVAC TEMPERATURE CONTROL

A. HVAC Temperature Controls and Sequence of Operations:

1. Contractor shall set and adjust automatically operated devices to achieve required sequence of operations.

2. Verify all controls for proper calibration and list those controls requiring adjustment.

B. Sequence of Operation for FTB-EF-1:

1. Exhaust fan shall be operated by thermostat with HAND-OFF-AUTO sub-base switch mounted on wall as shown on plans.

a. In HAND position, the fan shall run continuously. Motor actuator damper behind intake louver shall open. Auxiliary limit switch on damper actuator shall signal fan EF-1 to operate when damper (FTB-D-1) reaches the full open position.

b. In the AUTO position fan when space temperature rises to set point of 85 degrees F for EF-1, motor actuator damper behind intake louver shall open. Auxiliary limit switch on damper actuator shall signal fan EF-1 to operate when damper (FTB-D-1) reaches the full open position.

c. In the OFF position, fan is off. Motor actuator damper (FTB-D-1) behind intake louver shall close.

3.04 HVAC SYSTEM TESTING, ADJUSTING AND BALANCING

A. Contractor shall provide all necessary instrumentation, tools, ladders, and labor etc. to complete all air balancing, tests and adjustments.

B. Instrumentation shall be in accordance with NEBB, AABC, or SMACNA requirements and shall be calibrated to the accuracy standards demanded by these organizations.

C. All testing, adjusting, and balancing of air systems shall be performed in compliance with the standard procedure manual published by the testing, adjusting, and balancing organization affiliated with NEBB, AABC, or SMACNA Organization. Testing, adjusting, and balancing technician shall hold current certification by one of these organizations. Submit certification to Engineer for approval.

D. Contractor shall be solely responsible for the protection and safeguarding of his work and shall provide every protection against accidents, injury, and damage to persons and property.

E. Contractor shall keep dust, dirt, and debris to an absolute minimum and reinstall all removed ceiling components to their original positions at the end of each day.

F. Inspection: Contractor to perform inspection for proper installation and operation of all equipment.

1. Pre Startup Inspection:

a. Verify proper equipment mounting and setting.

b. Verify that control, interlock and power wiring is complete.

c. Verify alignment of motors and drives.

d. Verify proper connections and accessories.

e. Verify that lubrication is completed.

2. First Run Observations:

a. Verify direction of rotation.

b. Verify setting of safety controls.

c. Monitor heat build up in bearings.

d. Check motor loads against nameplate data.

3. Equipment Check:

a. Verify proper overload heater sizes.

b. Verify function of safety and operating controls.

c. Verify proper operation of equipment.

G. Air Systems Testing:

1. Test, adjust and balance systems in accord with the AABC "National Standards for Field Measurements, Total System Balance, Air Distribution, Hydronics Systems, Volume One Number 81266", or SMACNA's "Air Handling Specification".

2. Identify and list size, type and manufacturer of all equipment to be tested, including air terminals.

3. Test rpm for all equipment, including adjusting of each fan, air handling unit, air conditioning unit to design requirements within the limits of mechanical equipment provided.

4. Test and record motor voltages and running amperes including motor nameplate data, and starter heater ratings for each unit as listed above.

5. Make pitot tube traverse of main supply and exhaust ducts, determine cfm at all fans and units and adjust fans and units to within 5 percent of design requirements.

6. Test and record fan system static pressure.

7. Record all fan speeds.

8. Record air quantity delivered by each fan.

9. Distribution:

a. Adjust volume dampers, control dampers, etc., to proper design CFM in ducts.

10. Verification:

a. Prepare summation of readings of observed cfm for each system, compare with required cfm, and verify that duct losses are within specified allowable range.

b. Verify design cfm at fans as described above.

c. If the air systems are not properly balanced, the Contractor shall re-balance and recheck all data.

H. Automatic Control System:

1. In cooperation with the control supplier’s, set and adjust automatically operated devices to achieve required sequence of operations.

2. Testing organization technician shall verify all controls for proper calibration and list those controls requiring adjustment by Contractor or control system installer.

I. The test and balance activities described in this Section shall culminate in a report to be provided in quadruplicate (4), individually bound and also provided electronically to the Engineer. Neatly type and arrange data. Include with the data, the dates tested, personnel present, weather conditions, nameplate record of test instrument and list all measurements taken after all corrections are made to the system. Record all failures and corrective action taken to remedy incorrect situation. The intent of the report is to provide a reference of actual operating conditions for the Owner's operations personnel.

J. All measurements and recorded readings (of air, water, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

3.05 MANUFACTURER'S SERVICES

A. Heating, Ventilating and Air Conditioning Equipment:

1. Furnish services of qualified manufacturer's factory trained service personnel to assist in the installation of the equipment, check the installation before it is placed into operation, supervise initial operations and instruct plant operators in the care, operation and maintenance of the equipment.

3.06 CLEANING

A. Clean dirt and marks and other debris from exterior of equipment weekly.

B. Remove debris and waste material resulting from installation weekly.

3.07 GUARANTEE

A. All components, parts, and assemblies shall be guaranteed against defects in materials and workmanship for a period of one (1) year. The period of such warranties shall start on the date the particular equipment is placed in use by the Owner with corresponding start-up certification provided by the manufacturer's technical representative as specified herein, provided that the equipment demonstrates satisfactory performance during the thirty day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty day operational period, the start of the warranty period will be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to the Owner any part of equipment which is defective or showing undue wear within the guarantee period, or replace the equipment with new equipment if the mechanical performance is unsatisfactory; furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.

-END OF SECTION-

SECTION 15864

ELECTRIC UNIT HEATERS AND DEHUMIDIFIERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install all space heating units, and accessories, as shown on the Drawings and in accordance with the Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

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

B. Section 15500 - Basic HVAC Requirements

1.03 SUBMITTALS

A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01300, Submittals. Additional required information shall include: the approximate weight of the shipped materials. Shop drawings shall also include complete installation, and adjustment instructions and recommendations.

1.04 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01300, Submittals.

1.05 MANUFACTURERS

A. The materials covered by these specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

1.06 CONTRACTOR'S RESPONSIBILITY

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of each item of equipment furnished under this Contract and instruct the Owner's operating personnel in its maintenance and operation as outlined in Section 11000, Equipment General Provisions and in Division 1, General Requirements. The services of the manufacturer's direct employee, factory trained start up specialist shall be provided for a period of not less than one (1) full day.

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B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Engineer's Resident Project Representative on each day he is at the project.

C. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspection and outlining in detail any deficiencies noted.

D. The times specified are exclusive of travel time to and from the facility and shall not be construed as to relieve the manufacturer of any additional visits to provide sufficient service to place the equipment in satisfactory operation.

1.07 TOOLS, SUPPLIES AND SPARE PARTS

A. The electric space heating units shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the Shop Drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.08 IDENTIFICATION

A. Each electric space heating unit shall be identified with the identification number on the Drawings (e.g. FTB-EUH-1, FTB-EUH-2, etc.). A nameplate shall be securely affixed in a conspicuous place on each unit.

## PART 2 -- PRODUCTS

2.01 MANUFACTURER

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable firms regularly engaged in the manufacturing of electric space heating units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

2.02 ELECTRIC UNIT HEATERS

A. Product and Manufacturers: Provide completely factory assembled and wired units as made by one of the following:

1. Chromalox, a Division of Emerson Electric Company.

2. Indeeco - TRIAD. (Basis of Design)

3. Or Approved Equal.

B. Washdown/Corrosion resistant unit heater.

C. All necessary safety and temperature controls shall be included in a single package. Components and motor shall be factory-wired to a single terminal block for field wiring. Heater, fan motor and controls shall be connected to the same branch circuit.

D. Unit shall be stainless steel construction, epoxy-coated aluminum fan blade and nonmetallic NEMA 4X terminal enclosure.

E. Provide watertight construction so unit can be hosed down without disconnecting the heater.

F. Options:

1. Swivel mounting bracket.

2. Power disconnect switch.

3. Type 316 stainless steel finned tubular elements.

4. Heater on pilot light.

5. Secondary manual reset/over temperature cutout.

6. Three-position selector switch (heater-standby-fan).

7. Integral space thermostat 40° F to 110° F range, NEMA 4X rated enclosure, 125VA pilot duty.

G. The unit heater shall be supplied with a separate pilot duty type thermostat unless otherwise indicated. The control circuit shall operate on 120 VAC, single phase, 60 hertz derived from a control power transformer furnished and installed with the unit.

H. All heaters shall be UL listed and meet the requirements of the National Electrical Code. Electrical components for unit heaters shall be listed and labeled by U.L.

2.03 DEHUMIDIFIER

A. Product and Manufacturers: Provide completely factory assembled and wired units as made by one of the following:

1. Desert Aire (Basis of Design).

2. Dectron.

3. Or Approved Equal.

B. Capacity and electrical supply characteristics shall be as shown on Drawings.

C. Construction:

1. Enclosure: The frame, panels and removable access panels shall be constructed of 16 gauge Galvanneal steel. The base panels shall be 12 gauge Galvanneal steel. Removable panels will be provided to allow easy access to internal parts.

2. Paint and Finish: All metal parts will be painted using the following process:

a. Application of an alkaline cleaner and zinc phosphate

b. Clear water rinse

c. Application of a rinse sealant

d. Oven dry rinse sealant to provide clean dry surface for painting

e. Application is 11/2 to3 Mil powder coat paint

f. Powder coat is oven cured per pain manufacturer's specification

3. Corrosion Protection: All cabinet panels shall be constructed of zinc-iron coated Galvanneal steel and exhibit a spangle-free matte tan, uniform appearance.

4. Approval Listings: Unit shall be tested and approved in accordance with UL 474.

5. Evaporator and Condenser Coils:

a. Fins will be die formed, plate type tempered aluminum for easy cleaning and will be damage resistant. Fins will have extruded fin collars to provide maximum heat transfer.

b. Coil tubes will be fabricated from seamless drawn copper. Tubes will be mechanically expanded to for permanent metal to metal bond for maximum heat transfer and stability.

c. Manifold headers and connecting tubing will be made with heavy wall seamless copper tubing (evaporator coil only).

d. Coils will be leak tested with 625 psig nitrogen and sealed to prevent contamination.

6. Refrigeration: Unit shall be equipped with low ambient compensation valve to prevent system damage due to low load. Hot gas bypass valve will be sized to prevent evaporator coil freeze up regardless of entering air temperature for humidity level.

7. Compressor shall be heavy-duty fully hermetic, rotary type equipped with a high pressure safety switch and is internally protected from overheating. The compressor shall be vibration isolated internally and externally. Compressor is covered by a standard factory 2 year warranty.

8. Unit will be provided with wheels and handle kit, integral condensate pump with automatic cut-off safety in event of clogged drain tube, 20 feet of clear plastic drain tubing.

9. Unit shall come equipped with grounded 115 volt, 20 amp plug and minimum 6 feet of power cord.

## PART 3 -- EXECUTION

### 3.01 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall handle the unit (s) and components carefully to prevent damage, breaking, denting and scoring. Contractor shall not install damaged units or components.

B. The Contractor shall store the unit heaters, dehumidifiers and components in a clean dry place, which will adequately protect the units from weather, dirt, fumes, water, construction debris, and physical damage.

C. The Contractor shall comply with the manufacturer's transporting and installation instructions for unloading units, and moving them to final location.

### 3.02 INSTALLATION

A. The Contractor shall install unit heaters and dehumidifiers as indicated on the Drawings, in accordance with the manufacturer's installation instructions, and shall verify that the manufacturer's nameplate data corresponds with the unit designation.

B. The Contractor shall hang/support the units from substantial structural components of the building (e.g. walls, floors, columns, beams, etc.) unless unit such as dehumidifier is shown or indicated is to be floor/wheel mounted. Units shall not be hung from piping. The Contractor shall mount unit heaters as high as possible to maintain the greatest headroom possible unless otherwise indicated. The unit shall be supported with rod-type hangers anchored to building structural components and shall be protected with a protective cover during the balance of construction.

### 3.03 SEQUENCE OF OPERATION

A. Sequence of Operation for FTB-EUH-1 thru 6 and 11 thru 15 (Electric Unit Heater):

1. Unit heaters shall cycle ON and OFF as required to maintain space temperature of 60 degrees (adjustable) via wall mounted thermostat.

B. Sequence of Operation for FTB-EUH-7 thru 10 (Electric Unit Heater):

1. Unit heaters shall cycle ON and OFF as required to maintain space temperature of 55 degrees (adjustable) via wall mounted thermostat.

C. Sequence of Operation for FTB-DH-1 thru 5 (Dehumidifier):

1. Dehumidifiers shall cycle ON and OFF as required to maintain space relative humidity of 50% via internal humidistat.

3.04 ADJUSTING AND CLEANING

A. After installation is completed, the Contractor shall clean all exposed unit surfaces, vacuum the heating coils and vacuum the inside of the cabinets.

- END OF SECTION -

SECTION 15995

PIPELINE TESTING AND DISINFECTION

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall perform flushing and testing of all pipelines and appurtenant piping, complete, including conveyance of test water from Owner-designated source to point of use and all disposal thereof, all in accordance with the requirements of the Contract Documents.

### 1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

| | |
|---|---|
| ANSI/AWWA B300 | Hypochlorites |
| ANSI/AWWA B301 | Liquid Chlorine |
| ANSI/AWWA C651 | Disinfecting Water Mains |

### 1.03 SUBMITTALS

A. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval a minimum of 48 hours before testing is to start.

## PART 2 -- PRODUCTS

### 2.01 MATERIALS REQUIREMENTS

A. All test equipment, temporary valves or bulkheads, or other water control equipment and materials shall be determined and furnished by the Contractor subject to the Engineer's review. No materials shall be used which would be injurious to the construction or its future function.

## PART 3 -- EXECUTION

### 3.01 GENERAL

A. Unless otherwise provided herein, water for testing pipelines will be furnished by the Owner; however, the Contractor shall make all necessary provisions for conveying the water from the Owner-designated source to the points of use.

B. All pressure pipelines shall be tested. All testing operations shall be performed in the presence of the Engineer.

## 3.02 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, all pipelines shall be flushed or blown out as appropriate. The Contractor shall test all pipelines either in sections or as a unit. No section of the pipeline shall be tested until all field-placed concrete or mortar have attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. The Contractor shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Care shall be taken to see that all air vents are open during filling.

B. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air valves at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the Engineer shall be taken.

C. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for all piping shall be as specified in Section 15390. The test pressure for gravity lines shall be 25 psi. All visible leaks shall be repaired in a manner acceptable to the Engineer.

D. The maximum allowable leakage for pipelines shall be in accordance with the requirements of AWWA 600. In the case of pipelines that fail to pass the prescribed leakage test, the Contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.

## 3.03 DISINFECTION

A. Disinfection shall be accomplished after the pipe has been flushed, if applicable, and passed the hydrostatic test. Such piping shall be filled with 50 parts per million (PPM) of chlorine and held in contact for not less than 24 hours. Final tests after 24 hours contact time shall show a minimum residual chlorine content of 10 ppm in all parts of the system. Disinfection shall be repeated as often as necessary, and as directed by the Engineer and/or KDOW and/or the Owner until the minimum residual chlorine content of 10 ppm has been reached. The Contractor shall obtain certificates of satisfactory bacteriological tests and furnish them to the Owner before the request is made for acceptance of the work. The Contractor shall furnish and install, at his own expense, all means and apparatus necessary for performing the disinfection. The chlorine solution shall be thoroughly flushed out prior to placing the new sections of pipe in service. The Contractor is cautioned that the spent chlorine solution must be disposed of in such a way as not to be detrimental to animal, plant, or fish life. Chlorine residual tests will be made after flushing to assure that residual is not in excess of 1 ppm at any point in system.

B. The Contractor shall provide to the Engineer and Owner a list of equipment required to execute Work of this Section.

C. The Contractor shall operate all valves and other appurtenances during disinfection to assure the sterilizing mixture is dispersed into all parts of the system.

D. After the solution has been retained for the required time, pipes shall be flushed and filled with municipal domestic water. Sterilizing water shall be disposed of in an approved manner. Sterilizing water shall not be allowed to flow into a waterway without reducing chlorine concentrations to a safe level.

E. The Contractor shall take one bacteriological sample and test for every 1000 L.F. of pipeline or fraction thereof plus one sample at each dead end location. Samples shall be taken and tested on each of two successive days. Contractor shall submit samples to a laboratory, approved by Engineer, for testing. Utility company may also collect water samples at the same locations on the same two successive days for testing at their laboratory. Samples must be approved by both testing laboratories before the main is placed into service.

3.04 TESTS

A. Provide analysis of treated water to meet standards of Kentucky Division of Water (KDOW).

B. Test samples in accordance with AWWA C601.

C. Quality Assurance

1. Testing Laboratory: Certified for examination of drinking water in compliance with applicable legislation of the State of Kentucky.

D. Submittals

1. Submit name of testing laboratory and evidence of qualification.

2. Submit three copies of reports.

E. Project Record Documents

1. Submit reports under provisions of Section 01700.

2. The bacteriological report shall accurately record:

a. Date issued, project name, and testing laboratory name, address, and telephone number.
b. Time and date of water sample collection.
c. Name of person collection sample.
d. Test locations.
e. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
f. Coliform bacteria test results for each outlet tested.
g. Certification that water conforms, or fails to conform to bacterial standards of State of Kentucky
h. Bacteriologist's signature.

- END OF SECTION -

SECTION 16000

BASIC ELECTRICAL REQUIREMENTS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Subcontractor shall furnish all labor, materials, tools, and equipment, and perform all work and services necessary for, or incidental, to the furnishing and installation of all electrical work as shown on the Drawings, and as specified in accordance with the provisions of the Contract Documents and completely coordinate with the work of other trades involved in the general construction. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation shall be furnished and installed as part of this work. The Subcontractor shall obtain approved Shop Drawings showing wiring diagrams, connection diagrams, roughing-in and hook up details for all equipment and comply therewith. All electrical work shall be complete and left in operating condition in accordance with the intent of the Drawings and the Specifications for the electrical work.

B. Where the word "Subcontractor" appears in these Technical Specifications it shall be construed to mean the Electrical Subcontractor.

C. THE SUBCONTRACTOR SHALL REFERENCE THE FUNCTIONAL DESCRIPTIONS AND OTHER REQUIREMENTS FOUND IN DIVISION 17, CONTROL AND INFORMATION SYSTEMS, FOR ADDITIONAL REQUIREMENTS PERTAINING TO WORK UNDER THIS CONTRACT. THE FUNCTIONAL DESCRIPTIONS REFERENCED HEREIN SHALL BE CONSIDERED AS PART OF THE WORK REQUIRED UNDER THIS CONTRACT.

D. THE SUBCONTRACTOR SHALL BE RESPONSIBLE FOR ALL INTERCONNECTING DEVICES, CONDUIT, WIRE, AND APPURTENANCES NOT FURNISHED BY OTHERS BUT REQUIRED FOR THE OPERATION OF EQUIPMENT AS DESCRIBED IN THE FUNCTIONAL DESCRIPTIONS WHETHER SPECIFICALLY SHOWN ON THE DRAWINGS OR NOT.

E. The scope of work for this project primarily includes, but is not limited to, the following:

1. Furnish and install feeder to new filter building, 480V main circuit breaker.

2. Furnish and install a new standby engine generator set to replace existing, automatic transfer switch, new Chemical Building No. 2 emergency source disconnect and associated distribution panelboard.

3. Furnish and install low voltage motor control equipment including individually-enclosed variable frequency drives and reduced-voltage solid-state starters.

4. Furnish and install power panelboards, lighting panelboards, dry-type transformers, packaged power centers, and other low voltage electrical power distribution equipment.

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5. Furnish and install all aboveground raceway systems including conduit, fittings, boxes, and other pertinent components.

6. Furnish and install all underground raceway systems including conduit, fittings, handholes and other pertinent components.

7. Furnish and install new lighting systems and wiring devices.

8.

9. Install new field instrumentation, new controls equipment, and controls equipment relocated from the existing filter building to the new filter building.

10. Other electrical work as specified herein and indicated on the Drawings.

F. All electrical equipment shall conform to the applicable NEMA specifications.

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G. All electrical equipment shall be properly identified in accordance with these Specifications and Contract Drawings. Nameplates shall be engraved high pressure plastic laminate, white with black lettering. The nameplates shall be attached to the equipment cabinets with two (2) stainless steel sheet metal screws for nameplates up to 2-inch wide. For nameplates over 2-inch wide, four (4) stainless steel sheet metal screws shall be used, one (1) in each corner of the nameplate. All panelboards, starters, control panels, cabinet enclosures, and equipment switches shall be labeled in the manner described, or in an equally approved manner.

H. All materials, equipment, sizes and capacities of electrical equipment incorporated in the project shall conform to the latest requirements of the current National Electric Code, the National Electrical Manufacturer's Association, the State and local electrical codes, and to applicable rules and regulations of the local electrical utility serving the project.

I. All material and equipment must be the product of an established, reputable, and approved manufacturer; must be new and of first class construction; must be designed and guaranteed to perform the service required; and must bear the label of approval of the Underwriters Laboratories, Inc., where such approval is available for the product of the listed manufacturer as approved by the Contractor.

J. When a specified or indicated item has been superseded or is no longer available, the manufacturer's latest equivalent type or model of material or equipment as approved by the Contractor shall be furnished and installed at no additional cost to the Owner.

K. Where the Subcontractor's selection of equipment of specified manufacturers or additionally approved manufacturers requires changes or additions to the system design, the Subcontractor shall be responsible in all respects for the modifications to all system designs, subject to approval of the Contractor. The Subcontractor's bid shall include all costs for all work of the Contract for all trades made necessary by such changes, additions or modifications or resulting from any approved substitution.

L. Furnish and install controls for each piece of equipment requiring the controls under this Contract. The controls shall be the size and type recommended by the manufacturer for the application and as otherwise specified or indicted on the Drawings. Refer to Divisions 1 and

17 of the Specifications for control, connection and coordination descriptions and requirements.

M. Furnish and install all stands, racks, brackets, supports, and similar equipment required to properly serve the equipment which is furnished under this Contract, or equipment otherwise specified or indicated on the Drawings.

1.02 DRAWINGS

A. The Subcontractor shall furnish, install, and place in satisfactory condition ready for operation, all conduits, cables, and all other material needed for the complete lighting, power, control and other electrical systems shown or indicated in the Contract Drawings. Additional conduits and the required wiring shall be installed by the Subcontractor wherever needed to complete the installation of the specific equipment furnished.

1.03 EQUIPMENT LOCATION

A. The Drawings show the general location of feeders, transformers, outlets, conduits, and circuit arrangements. Because of the small scale of the Drawings, it is not possible to indicate all of the details involved. The Subcontractor shall carefully investigate the structural and finish conditions affecting all of his work and shall arrange such work accordingly; furnishing such fittings, junction boxes, and accessories as may be required to meet such conditions. The Subcontractor shall refer to the entire Drawing set to verify openings, special surfaces, and location of other equipment, or other special equipment prior to roughing-in for panels, switches, and other outlets. The Subcontractor shall verify all equipment dimensions to insure that proposed equipment will fit properly in spaces indicated.

1.04 LOCAL CONDITIONS

A. The Subcontractor shall examine the site and become familiar with conditions affecting the work. The Subcontractor shall investigate, determine, and verify locations of any overhead or buried utilities on or near the site, and shall determine such locations in conjunction with all public and/or private utility companies and with all authorities having jurisdiction. All costs, both temporary and permanent to connect all utilities, shall be included. The Subcontractor shall be responsible for scheduling and coordinating with the local utility for temporary and permanent services.

B. …TBD….The Subcontractor is responsible for coordinating all electric utility equipment installations with the serving electric utility. The Subcontractor shall furnish and install all electric utility equipment required by the electric utility to be installed by the Subcontractor whether specifically shown on the Drawings or not. The Subcontractor shall furnish and install the following electrical utility equipment as a minimum:

1. Primary and secondary ductbank and manholes

2. Primary conductors from the first utility pole within the property to the transformer

3. Cast coil transformer and associated concrete pad

4. Secondary conductors

5. Primary and Secondary terminations

The electric utility will furnish and install all equipment required for the following:

1. Modifications to the existing overhead distribution system

The Subcontractor is responsible for ensuring all electric utility equipment and construction installed by the Subcontractor is furnished and installed in accordance with the electric utility's design specifications and requirements. The Subcontractor is fully responsible for coordinating his scope of work with the electric utility. Any additional required electric utility construction or equipment not specified herein or shown on the Drawings shall be supplied by the Subcontractor at no additional cost to the Owner.

The contact person at the serving electrical utility for the plant site work is:

Curtis Warren
Kentucky Utilities
Major Accounts
One Quality Street
Lexington, Ky. 40507
(859)367-1291 (O)
(859) 227-5669 (C)
(859)367-5839 (F)
curtis.warren@lge-ku.com

1.05 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and the requirements of the individual specification sections, the Subcontractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Installation, Operation and Maintenance Manuals

3. Spare Parts List

4. Special Tools List

5. Proposed Testing Methods and Reports of Certified Shop Tests.

6. Reports of Certified Field Tests.

7. Manufacturer's Representative's Certification.

B. Submittals shall be sufficiently complete in detail to enable the Contractor to determine compliance with Contract requirements.

C. Submittals will be approved only to the extent of the information shown. Approval of an item of equipment shall not be construed to mean approval for components of that item for which the Subcontractor has provided no information.

D. Provide programming / set-up documentation associated with all electronic equipment including (but not limited to) VFD's / RVSS starter assemblies, and other related equipment complete with initially proposed settings and start-up configuration programming for review by the Engineer and Owner. This documentation is to precede installation of the equipment and is to provide the basis for the field programming and start-up work by the manufacturer's field technician.

1.06 APPLICABLE CODES AND REQUIREMENTS

A. Conformance

1. All work, equipment and materials furnished shall conform with the existing rules, requirements and specifications of the Insurance Rating Organization having jurisdiction, the serving electrical utility company, the latest edition of the National Electrical Code (NEC), the National Electric Manufacturers Association (NEMA), the Institute of Electrical and Electronic Contractors (IEEE), the Insulated Cable Contractors Association (ICEA), the American Society of Testing Materials (ASTM), the American National Standards Institute (ANSI), the requirements of the Occupational Safety Hazards Act (OSHA), and all other applicable Federal, State and local laws and/or ordinances.

2. All materials and equipment shall be Listed and Labeled by a Nationally Recognized Testing Laboratory (NRTL) acceptable to the Authority Having Jurisdiction (AHJ) in accordance with the National Electrical Code; Underwriters Laboratories, Inc. where applicable.

3. All control panels shall be UL-508A Listed and Labeled by the equipment supplier (Serial Identification not required). Listing/Labeling shall include the Suppliers Control Panel Fabrication Shop, under their UL File and Subscriber # assigned for this use. Additionally, Industrial Control Panels as defined under Article 409 of the NEC shall include the required SCCR for the assembly. The assembly shall be provided suitable for the available fault current within the power distribution; coordinated with the Power System Study.

4. All work shall be in accordance with local codes.

B. Nonconformance

1. Any paragraph of requirements in these Specifications, or Drawings, deviating from the rules, requirements and Specifications of the above organizations shall be invalid and their (the above organizations) requirements shall hold precedent thereto. The Subcontractor shall be held responsible for adherence to all rules, requirements and specifications as set forth above. Any additional work or material necessary for adherence will not be allowed as an extra, but shall be included in the Bid. Ignorance of any rule, requirement, or Specification shall not be allowed as an excuse for nonconformity. Acceptance by the Contractor does not relieve the Subcontractor from the expense involved for the correction of any errors which may exist in the drawings submitted or in the satisfactory operation of any equipment.

C. Certification

1. Upon completion of the work, the Subcontractor shall obtain certificate(s) of inspection and approval from the National Board of Fire Underwriters or similar inspection organization having jurisdiction and shall deliver same to the Contractor and the Owner.

1.07 PERMITS AND INSPECTIONS

A. The Subcontractor shall reference the General Conditions and Section 01010, Summary of Work.

1.08 TEMPORARY LIGHTING AND POWER

A. The Subcontractor shall reference the General Conditions and Section 01510, Temporary Utilities.

1.09 TESTS

A. Upon completion of the installation, the Subcontractor and/or a third party NETA Certified testing agency shall perform acceptance testing of equipment, as indicated herein. The qualifications of the testing company and resumes of the technicians as well as all data forms to be used for the field testing shall be submitted. Tests shall be made with and to the satisfaction of the Owner and Contractor. New equipment and material tests shall be made in accordance with the recommendations of the latest edition of NETA Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems; tests of existing installations to be in accordance with NETA Maintenance Testing Specifications. The Subcontractor and/or third party testing agency shall submit a testing plan indicating the specific tests to be performed. The Owner and Contractor shall review the test plan and may remove or add specific testing requirements.

B. The Subcontractor and/or third party testing agency shall perform all field tests and shall provide all labor, equipment, and incidentals required for testing and shall pay for electric power required for the tests. All defective material and workmanship disclosed shall be corrected by the Subcontractor at no additional cost to the Owner. The Subcontractor shall show by demonstration in service that all circuits and devices are in good operating condition. Test shall be such that each item of control equipment will function not less than five (5) times.

C. The following tests shall be completed by a NETA Certified third party testing agency:

- Low voltage cables #2 AWG and larger
- All grounding system testing as specified in this Contract
- All infrared inspections as specified in this Contract

All remaining tests shall be performed by the Subcontractor, and equipment manufacturer's representative, or a third party testing agency, at the Subcontractor's option.

D. The grounding system shall be tested to assure continuity and compliance with the requirement that ground resistances do not exceed 5 ohms when measured by the fall of potential test method. Upon completion of the installation and third party testing, the Subcontractor shall submit to the Contractor the grounding system test reports, indicating

the location of the rods and grounding system as well as the resistance and soil conditions at the time the measurements were made and shall also include the Fall of Potential Plot. Ground resistance measurements shall be made in normally dry weather not less than 48 hours after rainfall and with the ground under test isolated from other grounds. Ground resistance shall also be measured from each piece of equipment to the grounding electrode using a clamp-on type tester. Reference Section 16170, Grounding and Bonding, for additional requirements.

E. Insulation resistance testing of all incoming and outgoing cables for switchgear, motor control centers, lighting and power distribution panelboards, and similar equipment shall be done after the cables are in place and just prior to final terminations. All data shall be recorded, as per Exhibit "A", attached to the end of this Section.

F. Feeder circuits shall be tested with the feeder conductors disconnected from the supplied equipment.

G. The equipment to be tested shall include, but not be limited to, the following:

- Low Voltage Circuit Breaker Switchgear/Switchboards/Automatic Transfer Equipment
- Variable Frequency Drives and Related Motor Control Equipment
- Reduced-voltage solid-state (RVSS) “soft” starters and related motor control equipment.
- Panelboards
- Conduit System
- Cable and Wire
- Grounding System
- General Purpose Dry Type Transformers
- Lighting Fixtures (Indoor and Outdoor)
- Packaged Engine Generator Systems

H. Refer to each specific specification section for any further detailed field tests that may be required.

I. The Subcontractor shall complete the installation and testing of the electrical installation at least one (1) week prior to the start-up and testing of the respective equipment being served. During the period between the completion of electrical installation and the start-up and testing of all other equipment, the Subcontractor shall make all components of the Work available as it is completed for their use in performing Preliminary and Final Field Tests.

J. Before each test commences, the Subcontractor shall submit a detailed test procedure, and also provide test engineer resume, manpower and scheduling information for the approval by the Contractor. In addition, the Subcontractor shall furnish detailed test procedures for any of his equipment required as part of the field tests of other systems and certification/calibration documentation associated with the test equipment being provided.

K. Just prior to the final acceptance of a piece of equipment, an infrared inspection shall be performed to locate and correct all heating problems associated with that electrical equipment. The infrared inspection shall apply to all new equipment and existing equipment that is in any way modified under this Contract. All heating problems detected with new and modified equipment shall be corrected by the Subcontractor. Any problems detected with portions of existing equipment that were not modified under this Contract are not the

responsibility of the Subcontractor, however, these problems shall be reported to the Owner and Contractor immediately. The infrared inspection shall include both digital and IR pictures which shall be submitted to the Owner for record purposes.

1.10 DOCUMENTATION

A. The work requirements of this Section is in addition to and does not supersede testing and adjusting specified in other portions of the Contract Documents. The Subcontractor shall submit to the Contractor test records and reports for all testing.

1.11 PROTECTIVE DEVICE SETTING AND TESTING

A. The Subcontractor shall adjust, set, calibrate and test all low voltage protective devices in the electrical system. Protective device settings shall be provided to the Subcontractor as specified herein.

B. All protective devices in the electrical equipment shall be set, adjusted, calibrated and tested in accordance with the manufacturers' recommendations, the coordination study, and best industry practice.

C. Proper operation of all equipment associated with the device under test and its compartment shall be verified, as well as complete resistance, continuity and polarity tests of power, protective and metering circuits. Any minor adjustments, repairs and/or lubrication necessary to achieve proper operation shall be considered part of this Contract.

D. All solid state trip devices shall be checked and tested for setting and operation using manufacturers recommended test devices and procedures.

E. Circuit breakers and/or contactors associated with the above devices shall be tested for trip and close functions with their protective device. Conduct current injection testing for verification of trip functions associated with normal and arc flash reduction settings on protective devices which include these features.

F. When completed, the Subcontractor shall provide a comprehensive report for all equipment tested indicating condition, readings, faults and/or deficiencies in same. Inoperative or defective equipment shall be brought immediately to the attention of the Contractor.

G. Prior to placing any equipment in service, correct operation of all protective devices associated with this equipment shall be demonstrated by field testing.

1.12 POWER SYSTEM STUDIES

A. General

1. The Engineer will provide the Power System studies to the firm providing the protective device setting and testing services. The Subcontractor shall notify the Engineer three (3) weeks in advance of the scheduled date for the protective device setting and testing. The Subcontractor shall submit to the Engineer a tabulated listing of all protective devices requiring setting three (3) weeks prior to the setting and testing date. This table shall include the protective device manufacturer, model number, ampere rating (if applicable), instrument transformer ratios, and all other required information. In addition, the testing firm shall submit the programming and set-up documentation with initially proposed settings as previously specified. An arc

flash hazard analysis will be performed by the Engineer. The Subcontractor shall install arc flash hazard warning labels furnished by the Engineer.

1.13 SCHEDULES AND PLANT OPERATIONS

A. Since the testing required herein shall require that certain pieces of equipment be taken out of service, all testing procedures and schedules must be submitted to the Contractor and Owner for review and approval prior to any work beginning. The required length of advance notice prior to shutdown shall be closely coordinated with the Contractor and Owner. When testing has been scheduled, the Contractor and Owner must be notified 48 hours prior to any work to allow time for load switching and/or alternation of equipment. In addition, all testing that requires temporary shutdown of plant equipment must be coordinated with the Owner/Contractor so as not to affect proper plant operations.

B. At the end of the workday, all equipment shall be back in place and ready for immediate use should a plant emergency arise. In addition, should an emergency condition occur during testing, at the request of the Owner, the equipment shall be placed back in service immediately and turned over to plant personnel.

C. In the event of accidental shutdown of plant equipment, the Subcontractor shall notify plant personnel immediately to allow for an orderly restart of affected equipment.

1.14 MATERIALS HANDLING

A. Materials arriving on the job site shall be stored in such a manner as to keep material free of rust and dirt and so as to keep material properly aligned and true to shape. Rusty, dirty, or misaligned material shall be rejected. Electrical conduit shall be stored to provide protection from the weather and accidental damage. Rigid non-metallic conduit shall be stored on even supports and in locations not subject to direct sun rays or excessive heat. Cables shall be sealed, stored, and handled carefully to avoid damage to the outer covering or insulation and damage from moisture and weather. Adequate protection shall be required at all times for electrical equipment and accessories until installed and accepted. Materials damaged during shipment, storage, installation, or testing shall be replaced or repaired in a manner meeting with the approval of the Contractor.

(EXHIBIT A)
TEST DATA - MEGOHMS
TEST NO. ____

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date: | | | Company: | | | | |
| Time: | | | Location: | | | | |
| Circuit: | Circuit Length: | Aerial: | Duct: | Buried: | No. of Conduc-tors | Size: | AMG MCM Shld: |
| Insulation Material: | | | Insulation Thickness: | | Voltage Rating: | | Age: |
| Type: _____Pothead _____Terminal | | | | | Location: Indoors_____ Outdoors_____ | | |
| Number and Type of Joints: | | | | | | | |
| Recent Operating History: | | | | | | | |
| Manufacturer: | | | | | | | |
| State if Potheads or Terminals were grounded during test: | | | | | | | |
| List associated equipment included in test: | | | | | | | |
| Miscellaneous Information: | | | | | | | |

(EXHIBIT A)
TEST DATA - MEGOHMS
TEST NO. ____

Part Tested:Test Made:_____
Hours/Days:_____
After Shutdown:_____

Grounding Time:Dry Bulb Temperature:_____
Wet Bulb Temperature:_____

Test Voltage:

Equipment Temperature: _____
How Obtained: _____
Relative Humidity: _____
Absolute Humidity: _____
Dew Point: _____

Megohmmeter: Serial Number: _____ Range: _____
Voltage: _____ Calibration Date_____

| Test Connections | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground | Test Connections | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground | To Line<br>To Earth<br>To Ground |
|---|---|---|---|---|---|---|---|
| 3 Minute | | | | 5 Minutes | | | |
| 2 Minute | | | | 6 Minutes | | | |
| 3/4 Minute | | | | 7 Minutes | | | |
| 1 Minute | | | | 8 Minutes | | | |
| 2 Minutes | | | | 9 Minutes | | | |
| 3 Minutes | | | | 10 Minutes | | | |
| 4 Minutes | | | | 10/1 Minutes | | | |
| | | | | Ratio | | | |

Remarks:

## PART 2 -- PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

A. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

B. All items of the same type or ratings shall be identical. This shall be further understood to include products with the accessories indicated.

C. All equipment and materials shall be new, unless indicated or specified otherwise.

D. The Subcontractor shall submit proof if requested by the Contractor that the materials, appliances, equipment, or devices that are provided under this Contract meet the requirements of Underwriters Laboratories, Inc. or other NRTL's in regard to fire and casualty hazards. The label of or listing by the Underwriters Laboratories, Inc., will be accepted as conforming with this requirement.

## PART 3 -- EXECUTION

### 3.01 CUTTING AND PATCHING

A. Coordination

1. The Work shall be coordinated between all trades to avoid delays and unnecessary cutting, channeling and drilling. Sleeves shall be placed in concrete for passage of conduit wherever possible.

B. Damage

1. The Subcontractor shall perform all chasing, channeling, drilling and patching necessary to the proper execution of his Contract. Any damage to the building, structure, or any equipment shall be repaired by qualified mechanics of the trades involved at the Subcontractor's expense. If, in the Contractor's judgment, the repair of damaged equipment would not be satisfactory, then the Subcontractor shall replace damaged equipment at his own expense.

### 3.02 EXCAVATION AND BACKFILLING

A. The Subcontractor shall perform all excavation and backfill required for the installation of all electrical work. All excavation and backfilling shall be in complete accordance with the applicable requirements of Division 2.

3.03 CORROSION PROTECTION

A. Wherever dissimilar metals, except conduit and conduit fittings, come into contact, the Subcontractor shall isolate these metals as required with neoprene washers, nine (9) mil polyethylene tape, or gaskets.

B. Conduits extending from below grade and conduits extending out of a concrete slab shall be PVC coated RGS. See Section 16111-Conduit for details.

- END OF SECTION -

SECTION 16481

INDIVIDUAL MOTOR CONTROLLERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish and install separately mounted, individual motor controllers for 120 volt single phase, and 208 and 480 volt three phase motors as specified herein and indicated on the Drawings. Individual motor controllers specified in this Section include magnetic motor starters, manual motor starters, and reduced voltage solid state starters (RVSS).

B. Reference Section 16000, Basic Electrical Requirements and Section 16902, Electric Controls and Relays.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications referenced in Section 16000, Basic Electrical Requirements.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings.

2. Spare Parts List.

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

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B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Shop drawings shall include but not be limited to:

1. Product data sheets.

2. Complete layout and installation drawings with clearly marked dimensions and weights for each type/size/rating of individual motor controller including conduit entry locations where applicable.

3. Custom wiring diagrams for each individual motor controller. Standard wiring diagrams that are not custom created by the manufacturer for the individual motor controllers for this project are not acceptable. One wiring diagram which is typical for an equipment group (e.g. reuse water pump) is not acceptable. Each wiring diagram shall include wire identification and terminal numbers. Indicate all devices, regardless of their physical location, on the diagrams. Identify on each respective wiring diagram specific equipment names and equipment numbers consistent with those indicated on the Drawings.

4. Bill of material list for each individual motor controller.

5. Nameplate schedule for each individual motor controller.

6. Manufacturer's installation instructions.

7. Time-current curves for each type and size protective device if requested by the Engineer.

D. The shop drawing information shall be complete and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items that the Contractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for individual motor controller. These final drawings shall be plastic laminated and securely placed inside each individual motor controller unit door and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 TOOLS, SUPPLIES, AND SPARE PARTS

A. The equipment shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Contractor.

B. The Contractor shall furnish the following minimum spare parts:

1. One (1) solid state overload relay for each type, size, and rating used.

2. One (1) motor circuit protector & motor contactor for each type, size, and rating used.

3. One (1) spare control power transformer for each type and size used.

4. Two (2) spare fuses for each size and type used.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

E. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICE OF MANUFACTURER'S REPRESENTATIVE

A. For all reduced voltage solid state (RVSS) motor controllers, the Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day during installation of the equipment for <u>each</u> RVSS.

2. One trip of one (1) working day after acceptance of the equipment.

3. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor.

1.08 IDENTIFICATION

A. Each equipment item shall be identified with a nameplate. The nameplate shall be engraved indicating the circuit number and equipment name with which it is associated. Equipment identification shall be in accordance with Section 16195, Electrical - Identification.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all RVSS motor controllers provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.

1.10 CONSTRUCTION SEQUENCING

A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. Individual motor controllers specified in this section shall be as manufactured by Cutler-Hammer, the Square D Company, or Allen-Bradley. The basis of design for RVSS motor starters is the SMC Flex model manufactured by Allen-Bradley.

2.02 INDIVIDUAL MAGNETIC MOTOR STARTERS

A. Individual magnetic motor starters shall be combination type complete with motor circuit protectors (MCP's). Starters shall be rated 480 VAC, 3-pole, sized for the intended load unless otherwise indicated. In no case shall a starter smaller than a NEMA Size 1 be used. Each starter shall be furnished with a minimum of two spare auxiliary contacts.

B. Provide starters in NEMA 1A (gasketed) enclosures when located in clean, dry, conditioned spaces only. NEMA 1A (gasketed) enclosures shall be finished with corrosion resistant epoxy or acrylic paint. Starters to be furnished and installed in indoor damp or wet areas and outdoor locations shall be in NEMA 4X Type 304 stainless steel enclosures. Starters to be provided in all outdoor locations shall be in NEMA 4X Type 304 stainless steel enclosures. Individual motor starters located in hazardous areas shall be suitable for the Class, Division, and Group to suit the application.

C. Furnish and install manual reset overload relays in each phase sized in accordance with the NEC. Provide cover mounted overload reset button with metal (not plastic) shaft and pilot devices as indicated and required. Starters shall be provided with all coils and controls for 120 VAC operation, unless otherwise indicated on the Drawings.

D. A control power transformer shall be furnished and installed for each motor controller. The minimum control power transformer VA requirements are as follows:

| | |
|---|---|
| Size 1 | 75 VA |
| Size 2 | 75 VA |

| | |
|---|---|
| Size 3 | 200 VA |
| Size 4 | 300 VA |
| Size 5 | 500 VA |

Additional transformer capacity shall be provided when required. The motor controller manufacturer is advised to review the total Contract Documents for additional requirements for space heaters, power factor correction capacitors, and similar equipment which may not be specified in this Division or shown on the Drawings.

E. Each starter shall be supplied with a manual reset overload relay. Manual reset shall be accomplished by a door mounted overload reset pushbutton. The relays shall be solid state type, with at least one isolated normally open and one isolated normally closed auxiliary contact that operates when a trip condition has occurred. Relays shall be self-powered, have a visible trip indicator, have a trip test function, and have selectable Class 10 or 20 operation. Overload relays shall be set for Class 10 operation unless otherwise directed by the Engineer. Overload relay shall have phase loss protection built in to trip the unit and protect the motor against single phasing. The Contractor shall provide the overload relay model with the correct current range for each application. Overload relay shall have adjustable current range dial. Eutectic alloy and bi-metallic type overload relays shall not be used.

F. Unless otherwise indicated, the pilot devices shall be mounted on the covers of the respective enclosures. Pushbuttons, selector switches, and pilot lights shall be 30.5 mm, heavy-duty, oil tight type with provisions to maintain the NEMA ratings of starter enclosures. Legend plates indicating switch positions shall be provided for each pilot device. Pilot lights shall be LED push to test type.

G. All control wiring shall be No. 14 AWG (minimum) labeled at each end in accordance with the wiring numbers shown on the accepted shop drawings. Power wiring shall be sized to suit the maximum horsepower rating of unit; No. 12 AWG (minimum). Wiring shall be type MTW rated for 105ºC. Wire color coding shall be as specified in Section 16123, Building Wire and Cable.

H. Each motor starter coil shall be equipped with a surge-suppression device for protection of the solid state equipment (e.g. programmable logic controller) wired as part of the control circuit.

I. Where specified in these Contract Documents, indicated on the Drawings, or as required, interposing relays shall be furnished for the motor control circuits. Coil voltage shall be as specified, indicated on the Drawings, or as required. The contact ratings of the relays shall be coordinated with the burden of the motor starter coil. If the burden or other electrical requirements exceed the contact rating of general purpose, plug-in relays, machine tool type relays with adequate contact ratings shall be provided.

J. Individual magnetic motor starters shall be as manufactured by Cutler-Hammer using NEMA rated Freedom Series starters and contactors, the Square D Company equivalent, or Allen-Bradley . equivalent.

2.03 INDIVIDUAL MANUAL MOTOR STARTERS

A. Individual manual motor starters in enclosures as specified above shall be furnished and installed for outdoor and indoor exposed work. Furnish and install manual motor starters in outlet boxes with flush wall plates as required for concealed work.

B. Furnish and install manual motor starters with pilot lights and overload heater elements of correct rating based on motor nameplate data.

C. Manual motor starters shall be equipped with either a push button or toggle operator with reset device or mechanism accessible without opening the enclosure.

D. Individual manual motor starters for motors one (1) horsepower and less shall be Cutler-Hammer Type MS, the General Electric Company equivalent, the Square D Company equivalent, Allen-Bradley equivalent, or Siemens Energy & Automation, Inc. equivalent.

E. Individual manual motor starters for integral horsepower motors shall be Cutler-Hammer Type B100 or B101, the Square D Company equivalents, or Allen-Bradley equivalent.

2.04 AUXILIARY CONTROL RELAYS

A. Provide auxiliary control relays as required to suit the application and as shown on the Drawings. Control relays shall be as specified in Section 16902 - Electrical Controls and Relays. The number of contacts shall be as shown and as required to suit the application plus two spare normally open (N.O.) and two spare normally closed (N.C.).

2.05 REDUCED VOLTAGE SOLID STATE STARTER

A. The solid-state reduced-voltage starter shall be UL and CSA listed. The solid-state reduced-voltage starter shall be an integrated unit with power SCRs, logic board, an integral paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing. The starter shall meet all applicable requirements of this Section and other sections in this Division.

B. To ensure that pump or blower/motor load starting torque requirements are met, the Contractor shall furnish the starter of the next higher maximum continuous current rating than otherwise required based on the full load ampere rating of the motor.

The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each piece of equipment (e.g. backwash blower).

C. The RVSS shall be suitable for the following environmental conditions:

1. Operating Temperature: 0-50 degrees C

2. Humidity: 0-95 percent non-condensing.

3. Altitude: up to 3,300 feet.

D. The RVSS shall be suitable for operation on a 480 VAC, 3-phase, 60 Hertz system.

E. The SCR-based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage rating of 1400 volts PIV. Units using triacs or SCR/diode

combinations are not acceptable. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.

F. The integral paralleling run bypass contactor shall energize when the motor reaches full speed..

G. The starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be adjusted via the device keypad and shall have a motor full load ampere adjustment from 30 to 100% of the maximum continuous ampere rating of the starter. The starter shall have selectable overload class setting of 5, 10, 20 or 30. The starter shall be capable of either an electronic or mechanical reset after a fault. Units using bimetal or eutectic alloy overload relays are not acceptable. Overtemperature protection (on heat sink) shall be standard.

H. The starter shall provide protection against improper line-side phase rotation as standard. The starter shall stop the motor load if a line-side phase rotation other than A-B-C exists. .

I. The starter shall provide protection against a phase loss or unbalance condition as standard. The starter shall stop the motor load if a 50% current differential between any two phases is encountered.

J. The starter shall provide protection against a motor stall condition as standard.

K. The starter shall provide protection against a motor jam condition as standard.

L. The starter shall be provided with a form C normally open (NO), normally closed (NC) contact that shall change state when a fault condition exists. In addition, an indication on the device keypad shall indicate the type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).

M. The starter shall be provided with an unpowered internal “Run” contact rated for 24VDC or 120 VAC operation.

N. The following control function adjustments on the device keypad shall be provided:

1. Selectable Torque Ramp Start or Current Limit Start

2. Adjustable Kick Start Time

3. Adjustable Kick Start torque

4. Adjustable Ramp Start Time

5. Adjustable Initial Starting Ramp Torque

6. Adjustable Smooth Stop Ramp Time.

O. Enclosed units shall include a motor circuit protector (MCP) for short-circuit protection and quick disconnect means where shown on the drawings. If required, the unit shall include a 24 VDC power supply to be used as the primary control voltage source. A 120 VAC control power transformer, fused on both the primary and secondary sides, shall be provided as an additional control power source to power such devices as motor space heaters, solenoid valves, and similar control elements as required. Input isolation contactors shall be furnished as indicated on the Drawings.

P. Unless otherwise specified or indicated on the Drawings, the RVSS enclosure shall be NEMA 1A (gasketed), force ventilated, dead-front, with front accessibility. The enclosure shall be designed for both bottom and top entry. The enclosure shall be designed so rear access is not required for operations, maintenance, and repair tasks. The doors shall have full length piano type hinges and shall be braced to prevent sag when fully open.

The Contractor shall reference the Drawings for maximum dimensions of the RVSSs.

S. The reduced voltage solid state starter shall be the SMC-Flex with integral bypass as manufactured by Allen-Bradley, Cutler-Hammer equivalent, the Square D Company equivalent.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All individual motor starters shall be installed as indicated on the Drawings and as recommended by the equipment manufacturer.

- END OF SECTION -

SECTION 16495

VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, install, connect, test and place in satisfactory operating condition all variable frequency drives (VFD's) as specified herein and indicated on the Drawings.

B. The variable frequency drives specified herein shall be included with the mechanical equipment they control as a packaged unit with responsibility for performance and reliability resting with the mechanical equipment supplier.

B. Reference Section 11153, Vertical Turbine Pumps, Section 16000, Basic Electrical Requirements, Section 16902, Electric Controls and Relays, and Section 17900, Schedules and Control Descriptions, General.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests and Reports

a. Submit description of proposed testing methods, procedures, and apparatus.

b. Submit notarized and certified copies of all test reports.

c. Submit factory bench-test data to indicate that the manufacturer's proposed equipment has been tested in the specified arrangement and found to achieve specified accuracy.

3. Field Tests

a. Field tests shall be performed in accordance with requirements specified in the General Conditions, Division 1, and Section 16000, Basic Electrical Requirements.

B. Acceptance of a shop test does not relieve Contractor from requirements to meet field installation tests under specified operating conditions, nor does the inspection relieve the Contractor of responsibilities.

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C. Submit signed and dated certification that all of the factory inspection and testing procedures described herein have been successfully performed by the Contractor prior to shipment.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in General Conditions and Section 01300, Submittals, the Contractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Harmonic Study Report

3. Programming Guides/Manuals

4. Operation and Maintenance Manuals

5. Spare Parts List

6. Special Tools List

7. Reports of Certified Shop and Field Tests

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete, or illegible submittals will be returned to the Contractor without review for resubmittal.

C. Drawings submitted by the manufacturer shall be complete and documented to provide the Owner with operations and maintenance capabilities.

D. Shop drawings for each VFD shall include but not be limited to:

1. Layout drawings of the variable frequency drive system that include all cabinet or enclosure dimensions, access details, and weights.

2. Layout drawings of panels or enclosures showing size, arrangement, color, and nameplates. Drawings shall include the physical arrangement of door mounted devices located on the variable frequency drive enclosure. Sufficient detail shall be provided for locating conduit stub-ups. General "catalog data sheet" layout drawings which are not specific to the systems specified herein are not acceptable.

3. Custom schematic and interconnection wiring diagrams of all electrical work, including terminal blocks and identification numbers, wire numbers and wire colors. Standard schematics and wiring diagrams that are not custom created by the manufacturer for the variable frequency drives for this project are not acceptable. These drawings shall be circuit specific for each motor-load combination. Indicate all devices, regardless of their physical location, on these diagrams. Specific equipment names consistent with the Drawings shall appear on each respective diagram.

4. Complete single line diagrams indicating all devices comprising the variable frequency drive system including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system. Electrical ratings of all equipment and devices shall be clearly indicated on these single line diagrams.

5. Complete Bills of Material and catalog data sheets for all equipment and devices comprising the variable frequency drive system.

6. A complete list of recommended spare parts, including item descriptions, recommended quantities, and unit costs. The recommended list should be based on a maintenance plan where the Owner will remove and replace failed items to the lowest replaceable module/component level.

E. The shop drawing information shall be completed and organized in such a way that the Engineer can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "Soft Cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Contractor intends to provide are to provide are acceptable and shall be submitted.

F. Prior to completion and final acceptance of the project, the Contractor shall furnish and install "as-built" wiring diagrams for each VFD and bypass starter. These final drawings shall be plastic laminated and securely placed inside each VFD and starter door and included in the O&M manuals.

G. Product Data shall include, but not be limited to:

1. Functional diagrams that identify major system functional blocks and interfaces.

2. Special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

H. Harmonic Study and Data shall include but not be limited to:

1. Report of Harmonic Study to determine the harmonic distortion present in the voltage and current waveforms on motor terminals and in the electrical distribution system(s) caused by the variable frequency drive system as specified herein.

2. Voltage and current waveforms supplied by variable frequency drive at the motor leads.

3. Necessary descriptions regarding calculation method, assumptions, values and notations, basis for input information, manufacturer's harmonic content data, and calculation results interpretation.

I. Programming Guides and Manuals shall be submitted. If the variable frequency drive systems require computer software or configuration, provide copies of all programming guides/manuals. Flow charts and listings of software developed shall be submitted to the Engineer. Submit final flow charts and program listings no later than 6 weeks prior to factory testing of the system.

1.05 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions, Section 01300, Submittals and Section 11000, Equipment - General Provisions.

B. Operation and Maintenance Manuals shall also be provided in electronic format on CDROM.

1.06 TOOLS, SUPPLIES, AND SPARE PARTS

A. The VFD's and accessories shall be furnished with all special tools necessary to disassemble, service, repair, and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished by the Contractor to the Owner.

B. The Contractor shall furnish the following spare parts <u>for each VFD</u>:

1. One set of all power and control fuses for each variable frequency drive.

C. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

D. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts until completion of the Work, at which time they shall be delivered to the Owner.

E. Spare parts lists, included with the shop drawing submittal shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

F. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Contractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Contractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined in the General Conditions, Division 1, and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day for each VFD during installation and start-up/configuration of the equipment.

2. One trip of one (1) working day after acceptance of the equipment.

3. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Contractor. The manufacturer's representative shall sign in and out at the office of the Resident representative on each day he is at the project.

1.08 IDENTIFICATION

A. Each VFD shall be identified by the circuit number and equipment name as indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on each VFD. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.09 TRAINING

A. The Contractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section.

B. Provide the services of an experienced, factory trained technician or service engineer of the variable frequency drive manufacturer at the jobsite for minimum of 1 day for training of Owner personnel, beginning at a date mutually agreeable to the Contractor and the Owner. The technician shall be on duty at the site for at least 8 hours per day and shall be available 24 hours per day when required to advise concerning special problems with equipment and systems.

C. Include in the bid the training of personnel in the operation and maintenance of each furnished variable frequency drive pump control system. For the purpose of this training section of the Specifications, a system is by definition a group of pumps or equipment which all serve a common function (e.g. backwash pumps). Training shall include at least one session for 2 designated employees for each system.

1.10 WARRANTY

A. Contractor shall warrant that the material and workmanship of all components and the operation of the variable frequency drive system and auxiliary equipment is in accordance with the latest design practices and meets the requirements of this Specification.

B. Warranty work shall include, but not be limited to, the following:

1. Replace components found to be faulty and make changes in equipment arrangement or adjustments necessary to meet the equipment or functional requirements or this Specification.

2. Warranty shall include system rewiring and substitution and rebuilt or additional equipment required during trial operation or subsequent operation of the unit during the period of this warranty.

3. Warranty shall be in effect for a period of 24 months following final acceptance of the system.

1.11 CONSTRUCTION SEQUENCING

A. The Contractor shall reference Section 01520, Maintenance of Utility Operations During Construction, of these Specifications.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance. Equipment shall be designed, constructed, and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. It is the intent of these specifications that the VFD's be provided as individually-enclosed VFDs.

C. The Contractor shall obtain the VFD's from one manufacturer who shall also manufacture the enclosure and major equipment components. The manufacturer shall have a minimum of five years experience in the manufacture of similar units and shall have a general distribution to the electrical trade. Subcontracting of wiring will not be acceptable.

The VFDs shall be PowerFlex 753 as manufactured by Allen-Bradley, SV 9000 Series manufactured by Cutler-Hammer, Toshiba equivalent, Danfoss equivalent, or equal. The basis of design is the Allen-Bradley PowerFlex 753 packaged drive system.

D. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard three-wire "start-stop" and the Contractor shall furnish wiring accordingly.

E. Mechanical equipment manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for providing all load, torque, speed and performance requirements from the respective sources and integrating these into a variable frequency drive system that fulfills the requirements of this Specification.

F. The Contractor and variable frequency drive system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices including pushbuttons, selector switches and pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.

2.02 PRODUCT REQUIREMENTS

A. Variable speed drives shall be adjustable frequency, adjustable voltage, pulse width modulated (PWM) design. The units shall be microprocessor controlled, fully digitally programmable, and capable of precise and repeatable speed regulation of three phase 480 volt AC NEMA Design B induction motors. Variable frequency drives for other than

NEMA Design B induction motors (e.g. NEMA Design C) shall be coordinated with the requirements of that respective load.

Drive units shall perform continuous self diagnostics as well as load and drive self check on startup.

B. All drives shall have permanently mounted programming and display modules. These modules shall provide programming access to all drive parameters, display all fault codes to assist with diagnostics and provide a display of output speed in percent or load.

C. This specification describes variable speed motor control which includes the design, fabrication, testing, installation and support requirements for variable frequency drive systems for 3-phase, squirrel cage rotor, induction motors driving pumps or other equipment.

D. Each variable frequency drive to be a complete alternating current electric drive system including hardware, software, technical data, and spare parts necessary to accomplish variable speed operation of an induction motor and load combination in accordance with the requirements as indicated on the Drawings and as described in these Specifications. Contractor shall refer to Section 17900 of the Specifications for a functional control description of each variable frequency drive system.

E. Variable frequency drive system manufacturer shall be responsible for the design and performance of the entire drive system and shall either manufacture all items of equipment or supply them using coordinated specifications furnished to the original equipment manufacturers to insure compatibility and performance in accordance with this Specification. Variable frequency drive manufacturer shall coordinate with suppliers of the drive motors and driven equipment. Motors shall be as specified in Section 15170 and other specific equipment Sections of the Specifications.

F. Variable frequency drive system shall be suitable for operation as part of a 480 VAC, 3-phase, 60 Hertz power distribution system. The complete variable frequency drive system shall withstand the mechanical forces exerted during short circuit conditions when connected directly to a power source having available fault current of 65,000 amperes symmetrical at rated voltage.

G. The variable frequency drive system shall be suitable to operate on a limited power source engine-generator set. The system shall be provided with equipment and devices to prevent waveform distortion as specified herein.

H. Provide control and sequence logic as specified herein and indicated on the Drawings. Control and sequence logic shall be designed such that the motor-load combination can be operated in the manual mode upon control and sequence logic failure, including all necessary personnel and equipment safety interlocks.

2.03 DESIGN REQUIREMENTS

A. Each variable frequency drive system shall meet the requirements of this Specification without derating any of the induction motor operating parameters including service factor and nameplate horsepower. The variable frequency drive system manufacturer shall specifically identify special requirements or restrictions of the motor-load combination that may result from operation on the variable frequency drive system.

B. The variable frequency drive shall consist of a 6, 12 or 18 pulse diode semiconductor rectifier system, direct current link, and pulse width modulated inverter. The inverter shall invert the direct current voltage into an alternating current voltage at a frequency which shall be proportional to the desired speed. This alternating current voltage and frequency shall both vary simultaneously at a constant "Volts-Per-Hertz" ratio to operate the induction motor at the desired speed.

C. Variable frequency drive shall operate from fixed frequency power supply and convert this input power into variable speed induction motor shaft power as required by this Specification. Provide each variable frequency drive with a motor circuit protector as indicated on the Drawings which shall be padlockable. Provide each variable frequency drive with 5% line reactors at the input. Include the necessary drive controllers and output contactors to accomplish the intended control of the variable frequency drive system.

D. The drive shall operate the motor and produce full rated nameplate horsepower at the motor output shaft without exceeding motor nameplate full load current and with the motor not exceeding rated total temperature not including the additional temperature increment that constitutes the motor service factor. Motor shall retain its service factor when operated by the variable frequency drive.

E. The overall drive system efficiency shall be a minimum of 95 percent when operating the specified motor-load combination at rated voltage, frequency, and current.

This efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$

F. Power (Load) is the total 3-phase power delivered to the motor, measured at the output terminals of the drive system, including output filters or transformers. Power (Supply) is the total electrical power delivered to the drive system, measured at the input terminals of the variable frequency drive including input filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment. Include power input required for auxiliary equipment (e.g., controls, fans, air conditioning, pumps) for complete system operating in this Power (Supply) total.

G. Variable frequency drive shall provide smooth, stepless changes in motor speed and acceleration over the entire operating speed range from minimum to maximum speed (revolutions per minute). The variable frequency drive shall be provided with maximum and minimum frequency limits.

H. Variable frequency drive system to maintain a desired output frequency (setpoint) with a steady state accuracy of 0.5 percent of rated frequency of 60 Hertz for a 24 hour period.

I. Variable frequency drive to have an automatic current limit feature to control motor currents during startup and provide a "soft start" torque profile for the motor-load combination. The variable frequency drive shall also limit current due to motor winding or motor lead phase-to-phase short circuit or phase-to-ground short circuit. The current limit protection setting shall be field adjustable.

Variable frequency drive shall be furnished with programmable electronic overload and torque limits.

J. Drive system shall achieve a desired output frequency (setpoint) with a repeatability of 0.1 percent of rated frequency of 60 Hertz.

K. Drive system to be capable of operating the specified load continuously at any speed within the operating speed range of 10 percent to 100 percent of rated speed. The minimum and maximum continuous operating speeds shall each be adjustable within this speed range. The variable frequency drive shall provide for field adjustment of these setpoints.

L. Drive system controls to be microprocessor-based and have controlled linear acceleration capability to ramp up the speed, revolutions per minute, of the motor-load combination from the minimum selected operating speed to the maximum selected operating speed in a minimum of 30 seconds. Provide two (2) field-adjustable speed setpoints for the variable frequency drive to skip equipment resonant frequencies. Provide controlled linear deceleration capability. The acceleration and deceleration time limits shall be field adjustable to values up to 120 seconds.

M. Voltage or current unbalance between phases of the variable frequency drive output voltage shall not exceed 3 percent of the instantaneous values. The variable frequency drive system shall continuously monitor the output voltages and generate an alarm condition when the unbalance exceeds 3 percent. The system shall detect and generate a separate alarm for loss of any output phase voltage (single phasing). Phase unbalance shall be as defined by NEMA Standard MG-1.

N. Variable frequency drive system to operate continuously without interruption of service or damage to equipment during transient input voltage variations of plus or minus 10 percent for a duration of 15 cycles. Unacceptable voltage fluctuations on the supply bus shall cause under or overvoltage protection to trip and remove supply voltage from the drive system. Variable frequency drive output voltage regulation shall be plus or minus 2 percent.

The variable frequency drive system shall be furnished with line surge protection.

O. The Contractor shall size variable frequency drive system and components to provide, indefinitely, motor load current equal to 125 percent of the motor nameplate full load current.

The Contractor is fully responsible for the review of the mechanical specifications to determine specified motor speed, horsepower and full load amperes. This information is available in the applicable mechanical specifications for each pump, drive, conveyor, blower, etc. Reference the Table of Contents.

P. If deemed necessary by the mechanical equipment and variable frequency drive suppliers for the installation, the variable frequency drives shall be provided with output reactors or filters to prevent elevated voltage levels at the motor terminals.

2.04 OPERATING CONDITIONS

A. The following operating conditions are applicable for all equipment of this Specification.

1. Humidity: 0-95 percent.

2. Ambient Temperature: Minus 20 degrees Celsius to plus 50 degrees Celsius.

3. Altitude: up to 3,300 feet

4. Power Supply: 480 volts, 3-phase, 60 Hertz.

5. Available Short Circuit Duty: as specified herein.

2.05 SYSTEM FEATURES AND CHARACTERISTICS

A. Controls and indicators to accomplish operation and maintenance shall be located on the variable frequency drive equipment assembly as specified herein and indicated on the Drawings. As a minimum, each VFD shall provide indication of the following:

1. Input Voltage

2. Output Voltage

3. Output Current

4. Output Frequency

5. Output Speed: 0-100%

6. Run Indicator: Green

7. Stop Indicator: Red

8. Running Time Meter.

9. Enclosure Overtemperature.

10. Alarm Indicator: Amber.

11. Alarm Read-out: Display.

B. Each VFD shall provide the following automatic and manual controls:

1. Hand-Off-Auto Selector Switch (as required).

2. Start and Stop pushbuttons (as required).

3. Local Speed Potentiometer.

4. Alarm Reset Pushbutton.

5. 24 VDC coil pilot relay for remote run command.

6. Alarm auxiliary contacts and other devices as indicated on the Drawings and specified.

7. Provision for a run permissive from other equipment when the drive is in "Auto".

C. Each VFD shall provide "potential-free" output contacts for the following conditions:

1. Drive running.

2. Drive in "Auto" and all trip conditions cleared.

Pilot devices shall be as specified in Section 16902, Electrical Controls and Relays.

D. Variable frequency drive system shall provide a 4-20 mADC output signal that is proportional to the drive output frequency for use as speed feedback or control and remote speed indication.

E. Variable frequency drive system shall accept a 4-20 mADC input command signal to control the output frequency in the automatic and/or manual control modes as specified herein or indicated on the Drawings. The system shall accept the input increase/decrease command with a resolution that permits incremental changes in speed, revolutions per minute, equal to or less than 0.1 percent of rated speed.

G. Variable frequency drive shall be furnished with a multiple attempt restart feature.

I. Provide a motor circuit protector with shunt trip coil and current-limiting fuses for each variable frequency drive.

K. Provide variable frequency drive system with transmitted and received radio interference protection. In addition, provide protection against starting a rotating motor, both directions (coasting to zero speed and backspin). In the event that a motor automatic restart feature (catch the motor "on-the-fly") is provided in the drive controller as standard, this feature shall be capable of being disabled.

L. Variable frequency drive design shall include on-line diagnostics, with an automatic self-check feature that will detect a variable frequency drive failure which in turn affects motor operation and generates an alarm contact output rated for 125 VDC suitable for interfacing with the control system.

1. Diagnostics shall operate a visual alarm indicator that is visible on the variable frequency drive equipment cabinets without opening the cabinet doors.

2. Diagnostics shall provide an easily readable output that will isolate a failure.

3. Provide an event and diagnostic recorder to printout in narrative English of the specific fault(s) and the sequence in which the faults occurred. An indication of the "First Out" failure is a minimum for fault sequence detection.

4. Provide a normally open dry contact for each alarm function to enable remote indication. An Ethernet communication port shall be provided for possible future link to the plant control system.

2.06 ENCLOSURES

A. Unless otherwise specified or indicated on the Drawings, the variable frequency drive enclosures shall be NEMA 12, force ventilated, dead-front, with front accessibility. VFDs

integrated into motor control center structures shall meet the enclosure requirements for MCCs as specified in Section 16482, Motor Control Centers. Design enclosures for both bottom and top entry of cables. Design variable frequency drive system so that rear cabinet access is not required for operations, maintenance, and repair tasks. Other enclosure requirements are:

1. Treat metal surfaces and structural parts by phosphatizing prior to painting.

2. Apply a gun-metal gray undercoat to enclosures which is equal to zinc chromate.

3. Finish exterior of the enclosures in ANSI-61 gray enamel or furnish in a color to match the complete line-up of equipment as indicated on the Drawings and accepted by the Engineer.

4. The doors shall have full length piano type hinges.

5. Brace each door to prevent sag when fully open.

The Contractor shall reference the Drawings for maximum dimensions of the VFDs.

B. Furnish each variable frequency drive system with the control switches, alarm lights and indicators as specified herein and as indicated on the Drawings. Furnish main circuit breakers with an external operating handle interlocked with the door so that the door cannot be opened unless the disconnect is in the OFF position. Power supply to the motor from both the variable frequency drive and the bypass starter shall be capable of being positively locked in the OFF position. The disconnect shall be interlocked so that equipment cannot be energized when the door is open.

C. Electrical bus, including ground bus, shall be tin-plated copper. Power and control wiring shall be copper, color coded and identified in accordance with these Specifications.

D. Equipment shall be of modular construction allowing normal maintenance and repair to be done with ordinary hand tools. Design and install power electronic component assemblies so that, where practicable, components can be individually removed and replaced.

## 2.07 HARMONIC DISTORTION SUPPRESSION

A. A comprehensive pre-equipment-selection harmonic study shall be prepared by the Contractor. The results of this pre-equipment selection study shall be submitted to the Engineer as part of the submittals specified herein. Should this study indicate the need for tuned filters, line reactors, isolation transformers, or other harmonic distortion suppression equipment, these shall be supplied at no additional cost to the Owner. Indicate the location of the harmonic suppression equipment in the submittal data. Location is subject to acceptance by the Engineer.

B. The harmonic distortion values resulting from operation of all or any variable frequency drive-driven motor-load combinations operating at full load shall be as defined in IEEE Standard 519.

1. Maximum allowable total harmonic voltage distortion (THD): 5 percent of the fundamental.

2. Maximum allowable individual frequency harmonic voltage distortion: within the limits of IEEE standard 519.

3. Maximum allowable total demand distortion (TDD): within the limits of IEEE Standard 519-1992, Table 10.3.

4. Maximum allowable individual frequency harmonic demand distortion: within the limits of IEEE Standard 519-1992, Table 10.3.

5. The harmonic distortion levels shall be specific to the "Point of Common Coupling" (PCC) as defined in IEEE Standard 519 and indicated on the Drawings.

C. System single line diagrams and field access to the plant site will be provided to the Contractor for the purpose of providing this study. Contractor shall obtain from others other information that may be necessary to perform this study. Input data and other pertinent information used in harmonic study shall be coordinated by the Contractor with the following:

1. Input data/information/results of the short circuit fault analysis specified herein.

2. Electrical system configuration and electrical equipment shop drawing submittal data including, but not being limited to new non-linear loads, new linear loads, and new capacitors.

D. Preparation of this pre-equipment selection study does not relieve the requirement for the Contractor to perform and submit the results of a second, final comprehensive study prepared by a recognized independent authority acceptable to the Owner after equipment installation.

E. In addition, the Contractor shall field measure actual harmonic distortion and verify with tests performed by an independent authority acceptable to the Owner after satisfactory full-load operation.

F. As part of the specified harmonic studies and other work for this project, identify and correct resonance conditions in the electrical distribution system at no additional cost to the Owner. Shop drawings, data, location of the respective equipment and its connection to the electrical distribution system shall be acceptable to the Engineer.

G. Reference Section 16000, Basic Electrical Requirements for information gained from the electric utility company during the design period which could be used for the purpose of the harmonic study. Inclusion of this information, however, does not relieve the Contractor nor his suppliers of the responsibility of obtaining all the necessary information required to perform the harmonic study.

2.08 MISCELLANEOUS

A. Encapsulate critical components in ceramic or metal.

B. Auxiliaries, including fans, that are required for rated load operation at maximum ambient temperature, shall be 100 percent redundant. A new and unused spare replacement fan(s) or air conditioning unit(s), shipped in original carton, may be acceptable.

C. Circuit boards and electrical components shall meet the corrosion protection requirements specified in these Specifications. Varnished or epoxy encapsulated circuit boards and tropicalized contactors suitable for corrosive environments shall be furnished where the VFDs are not located in climate controlled areas.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. The VFD's shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. Install VFD's to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.

C. Include in the bid an allowance for factory-trained service personnel, other than sales representatives, to supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested by the Contractor and the results of these tests have been accepted by the Engineer.

### 3.02 PAINTING

A. All metal surfaces of the motor control equipment shall be thoroughly cleaned and given one prime coat of zinc chromate primer. All interior surfaces shall then be given one shop furnished coat of a lacquer of the nitro-cellulose enamel variety. All exterior surfaces shall be given three coats of the same lacquer. The color of finishing coats shall be as approved by the Engineer. Color chips shall be forwarded to the Engineer for color selection and approval prior to finish painting. The interior of the VFD enclosure shall be painted white.

B. Prior to final completion of the work, all metal surfaces of the equipment shall be cleaned thoroughly, and all scratches and abrasions shall be retouched with the same coating as used for factory finishing coats.

### 3.03 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each VFD assembly. The mat shall be long enough to cover the full length of each VFD system. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

SECTION 16496

AUTOMATIC TRANSFER SWITCH

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Subcontractor shall furnish, install, connect, test and place in satisfactory operation automatic transfer switches as specified herein and indicated in Drawings.

B. All devices and components of the automatic transfer switch shall be NEMA rated. IEC rated devices are unacceptable and shall be cause for rejection of the submittals/equipment.

1.02 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required

2. Certified Shop Tests and Reports

a. Automatic transfer switches shall be given routine factory tests. The factory tests shall demonstrate that the completed switches function correctly and that the required timing has been set. Certification of these settings shall be submitted to the Design/Builder upon request.

b. Test procedures shall be in accordance with UL-1008. During the 30 cycle withstand tests, there shall be no contact welding or damage.

c. The thirty cycle tests shall be performed without the use of current limiting fuses.

d. Oscillograph traces across the main contacts shall verify that contact separation has not occurred and there is contact continuity across all phases after completion of the test.

e. When conducting temperature rise tests in accordance with UL-1008, include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.

f. Manufacturer shall submit test reports upon request.

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3. Field Tests

a. Field testing shall be done in accordance with the requirements specified in the General Conditions, Division 1, and NETA acceptance testing specifications referenced in Section 16000, Basic Electrical Requirements.

b. Prior to acceptance of the installation, load test the equipment under load. Correct defects which become evident during this test.

1.03 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Subcontractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Operation and Maintenance Manuals

3. Spare Parts Lists

4. Special Tools List

5. Reports of certified shop tests shall be submitted which indicates a closing and withstand ampere rating as required based on short circuit study requirements. Rating shall be symmetrical, 30 cycles at 480 VAC.

6. Guarantee/Warranty Program

B. Each submittal shall be identified by the applicable specification section.

1.04 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Subcontractor for resubmittal without review.

C. Shop drawings for <u>each automatic transfer switch</u> shall include but not be limited to:

1. Product data sheets.

2. Complete assembly, layout, and installation drawings with clearly marked dimensions and conduit entrance locations.

3. Example equipment nameplate data sheet.

4. Complete internal schematic and interconnecting wiring diagrams. Standard wiring diagrams that are not custom created by the manufacturer for the automatic transfer switch for this project are not acceptable.

5. Nameplate schedule.

6. Manufacturer's standard installation instructions.

7. Manufacturer's standard warranty.

D. The shop drawing information shall be complete and organized in such a way that the Design/Builder can determine if the requirements of these specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar information which is "highlighted" or somehow identifies the specific equipment items the Subcontractor intends to provide are acceptable and shall be submitted.

E. Prior to completion and final acceptance of the project, the Subcontractor shall furnish and install "as-built" wiring diagrams for each automatic transfer switch. These final drawings shall be plastic laminated and securely placed inside each transfer switch and included in the O&M manuals.

1.05 OPERATION AND MAINTENANCE MANUALS

A. The Subcontractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

1.06 TOOLS, SUPPLIES AND SPARE PARTS

A. The automatic transfer switches shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Subcontractor.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Subcontractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts lists, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

1.07 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. The Subcontractor shall provide the services of a qualified manufacturer's technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Subcontractor's personnel and the Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of one (1) working day during installation of the equipment.

2. On trip of one (1) working day to program parameters and test transfer switch in conjunction with standby generator.

3. One trip of one (1) working day after acceptance of the equipment.

4. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Subcontractor.

C. The manufacturer shall have an established network of service centers capable of servicing the specified equipment. The manufacturer shall have a service center within 200 miles of the project site which shall stock parts necessary to service the switch. The manufacturer shall include a toll-free telephone number for a field service contact affixed to each enclosure.

D. Service center personnel shall be on call 24 hours a day, 365 days a year. Personnel shall be factory-trained and certified in the maintenance and repair of the specified equipment.

E. After-warranty service contracts shall be made available to the Owner by the manufacturer, through the service centers, to provide periodic maintenance and/or repair of the specified equipment.

1.08 IDENTIFICATION

A. Each automatic transfer switch shall be identified with the identification number indicated on the Drawings (e.g. ATS-FB, etc.). A nameplate shall be securely affixed in a conspicuous place on each switch. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.09 TRAINING

A. The Subcontractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.

B. Provide the services of an experienced, factory trained technician or service engineer of the switch manufacturer at the jobsite for minimum of four (4) hours for training of Owner personnel, beginning at a date mutually agreeable to the Subcontractor and the Owner.

1.10 WARRANTY

A. The manufacturer shall warrant each automatic transfer switch for a minimum of five (5) years from date of shipment. In addition, the manufacturer shall repair or replace equipment found faulty under the terms of the warranty. The manufacturer shall submit data outlining the guarantee/warranty program.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The equipment described herein, as a minimum, shall meet all of the requirements specified in this Section and shall be a product of a manufacturer who has produced automatic transfer switches for a period of at least five (5) years. The equipment shall be compatible with the loads to be served. Assembly of the switches by a fabricator is not acceptable.

C. The manufacturer of the automatic transfer switch shall verify that the switches are listed by Underwriters Laboratories, Inc., standard UL-1008, with 30-cycle withstand and close-in values as indicated on the Drawings or specified herein.

D. The automatic transfer switches shall be Model RTS-30 as manufactured by Russelectric, Inc., Zenith ZTS equivalent, or ASCO Series equivalent.

2.02 AUTOMATIC TRANSFER SWITCH

A. General

1. Switches shall have ampere ratings and number of poles as indicated on the Drawings and shall be suitable for 480 VAC, three-phase, 60 Hertz operation.

2. For three phase, four-wire systems where a neutral is required, a true four-pole switch shall be supplied with all four electrically and mechanically identical poles mounted on a common shaft. The continuous current rating and the closing and withstand rating of the fourth pole shall be identical to the rating of the main poles.

3. The transfer switch shall have both top and bottom mounted cable access.

4. The switch shall be capable of switching all classes of load and rated for continuous duty when installed in a non-ventilated enclosure.

5. The 30-cycle closing and withstand current rating of the switch shall be 42,000 amperes RMS (minimum). This rating shall not be restricted by the use of a specific manufacturer's circuit breaker.

6. This switch shall be complete with all accessories and listed by UL under Standard UL-1008 for use on emergency systems.

7. All bolted bus connections shall have Belleville compression type washers. Switches for four-wire systems shall be furnished with a fully rated solid neutral bus.

8. The switch shall be equipped with 90°C rated copper/aluminum solderless mechanical type lugs of the proper quantity and size to accommodate the termination of field wiring.

9. Switches shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation.

B. Design Requirements

1. The switch shallutilize dual operators. Operators shall provide for an adjustable neutral off position in which the load is disconnected from both sources during transfer from utility to generator and re-transfer back the utility.

2. Switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.

3. The time delay between the opening of the closed contacts and the closing of the open contacts shall allow for voltage decay before transfer, allowing the motor and transformer loads to be re-energized after transfer with normal in-rush current. Switches using in-phase monitors are not acceptable.

4. Normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts to be of silver-tungsten alloy, mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets. Provide separate arcing contacts, with magnetic blowouts on each pole. Interlocked molded case circuit breaker switches or contactors are not acceptable.

5. Equip the transfer switch with a permanently attached, safe, manual operator designed to prevent injury to personnel in the event the electrical operator should become energized during manual transfer. The manual operator shall provide the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from slowly switching the main contacts and shall be operable with the transfer switch enclosure door closed.

C. Sequence of Operation

1. Should the voltage on any phase of the normal source drop below 80 percent or increase to 120 percent, or frequency drops below 90 percent, or increase to 110 percent, or 20 percent voltage differential between phases occur, after a programmable time delay period of 0-9999 seconds factory set at three (3) seconds to allow for momentary dips, the engine starting contact(s) shall close to start the standby plant or connect to the standby source.

2. Transfer to the standby power source shall occur when 90 percent of rated voltage and frequency has been reached by the standby power source.

3. After restoration of normal power on all phases to a preset value of 90 percent to 110 percent of rated voltage, at least 95 percent to 105 percent of rated frequency, and voltage differential is below 20 percent between phases, an adjustable time delay period of 0-9999 seconds factory set at 300 seconds shall delay the transfer to allow stabilization of the normal source. Should the standby source fail during this time delay period, the switch shall automatically retransfer to the normal source.

4. After retransfer to the normal power source, the standby plant shall operate at no load for a programmable period of 0-9999 seconds factory set at 300 seconds.

Should the normal power source fail during this time delay period, the transfer switch shall automatically return to the standby source.

D. Controls

1. The transfer switch shall be equipped with a microprocessor-based control system to provide all the operational functions of the automatic transfer switch. The controller shall have two asynchronous serial ports. The controller shall have a real time clock with Nicad battery back-up.

2. The CPU shall be equipped with self diagnostics which perform periodic checks of the memory, I/O, and communication circuits with a watchdog power fail circuit.

3. The serial communication port shall allow interface to either the manufacturer's or the Owner's furnished remote supervisory control system.

4. The controller shall have password protection to limit access to authorized personnel.

5. The controller shall include a 20 character LCD display with a keypad, which allows access to the system.

6. The controller shall include three-phase over/under voltage, over/under frequency, phase sequence detection, and phase differential monitoring on both normal and standby sources.

7. The controller shall be capable of storing the following records in memory for access either locally or remotely:

   a. Number of hours the transfer switch is in the standby position (total since record reset).

   b. Number of hours standby power source is available (total since record reset).

   c. Total transfer in either direction (total since record reset).

   d. Date, time, and description of the last four source failures.

   e. Date of the last exercise period.

   f. Date of record reset.

8. Controller shall indicate:

   a. Switch is in normal position

   b. Switch is in standby position.

   c. Controller is running.

9. An LCD readout shall display both normal source and standby source availability.

10. The microprocessor controller shall meet the following requirements:

    - Storage conditions - 25°C to 85°C
    - Operation conditions - 20°C to 70°C ambient
    - Humidity 0 to 99% relative humidity, non-condensing
    - Capable of withstanding infinite power interruptions
    - Surge withstand per ANSI/IEEE C-37.90A-1978

11. All control wiring shall be 18 gauge (minimum), 600 VAC, SIS switchboard type. All control wiring shall be identified at each termination (both ends) using tubular, sleeve-type wire markers.

12. The automatic transfer switch controller shall be a Model RPTCS as manufactured by Russelectric,GE Zenith Controls equivalent, or ASCO equivalent. The controller shall be programmed by themanufacturer's field representative during start-up and testing in conjunction with standby generator.

E. Accessories

1. Programmable three phase sensing of the normal source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

2. Programmable three phase sensing of the standby source set to pickup at 90% and dropout at 80% of rated voltage and overvoltage to pickup at 120% and dropout out at 110% of rated voltage. Programmable frequency pickup at 95% and dropout at 90% and over frequency to pickup at 110% and dropout at 105% of rated frequency. Programmable voltage differential between phases, set at 20%, and phase sequence monitoring.

3. Time delay for override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds.

4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds, with overrun to provide programmable 0-9999 second time delay, factory set at 300 seconds, unloaded engine operation after retransfer to normal.

5. Time delay on transfer to standby, programmable 0-9999 seconds, factory set at 3 seconds.

6. A maintained type load test switch shall be included to simulate a normal power failure, keypad initiated.

7. A time delay bypass on retransfer to normal shall be included. Keypad initiated.

8. Contact, rated 10 A at 30VDC, to close on failure of normal source to initiate engine starting.

9. A plant exerciser shall be provided with (10) 7 day events, programmable for any day of the week and (24) calendar events, programmable for any month/day, to automatically exercise the standby plant programmable in one minute increments. Also include a control switch for selection of either "no load" (switch will not transfer) or "load" (switch will transfer) during the exercise period. Keypad initiated.

10. Relay contacts which close when normal source fails wired to a terminal strip.

11. Relay contacts which open when normal source fails wired to a terminal strip.

12. Relay contacts which close when emergency source is available wired to a terminal strip.

13. Relay contacts which open when emergency source is available wired to terminal strip.

12. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on normal and wired to a terminal strip.

13. Two auxiliary contacts rated 15 A at 120 VAC on main shaft, closed on standby and wired to a terminal strip.

14. Provide a preferred source selector switch to permit the selection of either source as the "preferred" source which the ATS will always seek if that source is available. The two-position selector switch shall have a legend plate which reads "Source A/Source B." Selector switch shall only be provided for the indoor transfer switches at the plant site.

2.03 ENCLOSURES

A. The transfer switches shown to be installed indoors shall be housed in a NEMA 1 (gasketed) enclosure fabricated from 12-gauge steel. The enclosure shall exceed the UL-1008 minimum wire bending space requirements. The enclosure shall be equipped with an internal, welded steel, door-mounted print pocket.

B.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Each automatic transfer switch shall be installed as shown on the Drawings and in accordance with the manufacturer's installation instructions.

B. The automatic transfer switch shall be provided with adequate lifting means for installation of wall or floor mounted enclosures.

C. The Subcontractor shall tighten all assembled bolted connections to the manufacturer's torque recommendations prior to energizing.

D. Install each switch to allow complete door swing required for component removal. This is specifically required where a switch is set next to a wall to the left of the switch enclosure.

3.02 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of each indoor automatic transfer switch. The mat shall be long enough to cover the full length of each enclosure. The mat shall be 1/4 inch thick with beveled edges, canvas back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

SECTION 16620

PACKAGED ENGINE GENERATOR SYSTEMS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Subcontractor shall furnish and install a standby power engine generator set complete with base-mounted fuel storage tank, leak detection systems, piping, exhaust silencer, batteries, charger, enclosure, and devices for automatic and manual control.

B. It is the intent under this Contract to require an installation complete in every detail whether or not indicated on the Drawings or specified. Consequently, the Subcontractor is responsible for all details, devices, accessories and special construction necessary to properly install, adjust, test, and place in successful and continuous operation the engine-generator set.

C. Use materials which are new, unused, and as specified, or, if not specifically indicated, the best and most suitable of their kinds for the purpose intended, and for the design and expected conditions of service, subject to the approval of the Design/Builder.

D. Provide workmanship that is first class in every respect. Employ workers thoroughly experienced in such work. A neat and workmanlike appearance in the finished work shall be required.

E. All materials used must bear the inspection labels of the Underwriter's Laboratories, if the material is of a class inspected by the Laboratory.

F. Unless otherwise indicated, the materials to be provided under this Specification shall be the products of manufacturers regularly engaged in the production of all such items and shall be the manufacturer's latest design. The products shall conform to the applicable standards of UL and NEMA, unless specified otherwise. International Electrotechnical Commission (IEC) standards are not recognized. Equipment designed, manufactured, and labeled in compliance with IEC standards is not acceptable.

G. The engine generator sets shall fully comply with all current Environmental Protection Agency (EPA) emission regulations including, but not limited to, the New Source Performance Standards (NSPS) for stationary and non-road generator sets. The engine generator set(s) must meet the EPA new source performance requirements required at the time the engine generator set(s) submittal is approved by the Design/Builder. Engines manufactured previous to the submittal approval date that do not meet the current regulated emissions levels are not acceptable.

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### 1.02 CODES AND STANDARDS

A. The packaged engine-generator system shall comply with the following Codes and Standards as a minimum:

1. NEMA MG1, Motors and Generators.

2. NEMA MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Motors and Generators.

3. ISO STD 8528, Reciprocating Internal Combustion Engines.

4. ISO STD 3046, Performance Standard for Reciprocating Internal Combustion Engines.

5. NFPA 30, Flammable and Combustible Liquids Code.

6. NFPA 37, Standard for Installation and use of Stationary Combustible Engine and Gas Turbines.

7. NFPA 70, National Electrical Code

8. NFPA 70E, Standard for Electrical Safety in the Workplace

9. UL 508, Industrial Control Equipment.

10. EGSA, Electrical Generating Systems Association.

11. UL 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.

12. UL 2200, Stationary Engine Generator Assemblies

1.03 TESTING

A. All tests shall be performed in accordance with the requirements of the General Conditions and Division 1. The following tests are required:

1. Witnessed Shop Tests

a. None required.

2. Certified Shop Tests and Reports

a. Fully test the engine-generator set with all accessories in the manufacturer's plant before shipment; test at various loadings from full load to no load, and at such other conditions as to properly establish that all requirements have been met. Tests shall be conducted through the use of balanced, three-phase, inductive load banks. Tests shall be made at 80% power factor. Obtain Design/Builder's approval before shipment is made.

b. The manufacturer shall submit recommended shop testing procedures and durations for review and acceptance by the Design/Builder.

c. Submit two (2) certified copies of all test reports.

3. Field Tests

a. Field tests shall be performed in accordance with the requirements specified in the General Conditions, Division 1.

b. In the presence of the Design/Builder inspect, adjust and test the entire system after installation and leave in good working order. Tests shall be conducted through the use of balanced, three-phase, dry-type, resistive load banks. Temporary transformers shall be furnished as required if the generator voltage does not match the load bank voltage. Notify the Design/Builder by letter approving such installation as ready for test two (2) weeks prior to the running of the specified field test. Field tests shall be conducted after the entire system is completely installed. Field tests shall include, but are not limited to, the silencer, radiators, engine-generators, switchgear, and all other equipment included in the complete system.

c. Conduct a continuous test run of at least three (3) consecutive hours without shutdown for the set under the following conditions of load.

5 mins - no load
15 mins - 1/4 load
30 mins - 1/2 load
30 mins - 3/4 load
1.5 hours - full load

At the conclusion of the full load test, the generator shall be shut down and an NFPA 110 Hot Restart test shall be performed. Re-start and run the generator at full load for an additional 10 minutes.

Record complete test data for frequency, amperes, volts, power factor, exhaust temperature, coolant temperature, ambient temperature (dry and wet bulb) and oil pressure every 15 minutes during the continuous run test. If any failures and/or shutdowns occur during this seven (7) hour test, the problems shall be fixed and the test shall be restarted. The test shall not be considered complete until the generator has operated for seven (7) consecutive hours without any shutdowns under the conditions listed above.

Record environmental conditions for outdoor temperature, relative humidity and inside enclosure temperature and relative humidity. These readings shall be taken at the beginning and end of each load step. From this data, the manufacturer shall provide projected equipment conditions for max summer environment using full operational loading.

d. In addition to the load tests listed above and in the presence of the Design/Builder, the generator and automatic transfer switch shall be tested as a system under simulated utility loss. The system shall successfully transfer and retransfer under simulated utility loss three (3) times without any failures. If any failures occur during the load transfer tests listed above, the problems shall be fixed and tests shall be restarted. The load transfer tests shall not be considered complete until the generator and transfer switch control system has completed all the transfer tests listed above without any shutdowns.

The Subcontractor shall coordinate any possible plant shutdowns that may occur during the transfer tests under plant load with the plant Owner before proceeding with the plant load tests.

e. After successful completion of the resistive load bank test, the generator shall then be operated for 4 hours with facility loads during a time period when the facility is operating at or near maximum demand. An allowance of one (1) day field service shall be provided for this task.

f. Field test, as far as practicable, all control, shutdown, and alarm circuits. These include, but are not limited to, high coolant temperature, low oil pressure, engine overspeed, engine overcrank, engine fail, and other circuits. Document the successful completion of these tests as witnessed by the Design/Builder.

g. Arrange to furnish two (2) days service of a qualified manufacturer's representative for supervising the field testing of the equipment; also furnish any technical assistance required to ensure a proper and operable installation. During this period have manufacturer's representative instruct the Owner in the operation, maintenance, repair and adjustment of all equipment furnished under this Section. The service representative shall be scheduled for field testing on the same day as the representative for the switchgear.

h. The Subcontractor shall provide and pay for all fuel, lubricants, and other fluids as required for field testing. At the conclusion of the field testing, and prior to the acceptance by the Owner, the fuel and oil filters shall be replaced. Spare filters to be provided under this contract shall not be used for this purpose.

1.04 SUBMITTALS

A. In accordance with the procedures and requirements set forth in the General Conditions and Section 01300, Submittals, the Subcontractor shall obtain from the equipment manufacturer and submit the following:

1. Shop Drawings

2. Spare Parts List

3. Special Tools List

4. Reports of Certified Shop and Field Tests

5. Operation and Maintenance Manuals

B. Each submittal shall be identified by the applicable specification section.

1.05 SHOP DRAWINGS

A. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed equipment's compliance with the Contract Documents.

B. Partial, incomplete or illegible submittals will be returned to the Subcontractor without review for resubmittal.

C. Shop drawings for each engine-generator set shall include but not be limited to:

1. A Compliance, Deviations, and Exceptions (CD&E) letter. If the shop drawings are submitted without this CD&E letter, the submittal will be rejected. The letter shall include all comments, deviations and exceptions taken to the Drawings and Specifications by the Contractor AND Equipment Manufacturer/Supplier. This letter shall include a copy of this specification section. In the left margin beside each and every paragraph/item, a letter “C”, “D”, or “E” shall be typed or written in. The letter “C” shall be for full compliance with the requirement. The letter “D” shall be for a deviation from the requirement. The letter “E” shall be for taking exception to a requirement. Any requirements with the letter “D” or “E” beside them shall be provided with a full typewritten explanation of the deviation/exception. Handwritten explanation of the deviations/exceptions is not acceptable. The CD&E letter shall also address deviations, and exceptions taken to each Drawing related to this specification section.

2. Standard manufacturers printed specification sheet showing critical engine and generator set specifications including the following:

- Dimensions, and weights
- Guaranteed fuel consumption at 25%, 50%, 75% and 100% of full rated load
- Engine bhp available
- Engine jacket water heat rejection
- Exhaust flow rate and temperature at 100% of rated load
- Ventilation and combustion air requirements
- Exhaust backpressure limitation
- Liquid refill capacities
- Generator efficiency at 50%, 75%, and 100% load
- Telephone Interference Factor (TIF)
- Harmonic waveform distortion
- Type of winding insulation and generator temperature rise
- Voltage regulation characteristics
- Guaranteed noise levels
- Per unit subtransient impedance X’’ and X/R ratios for positive, negative, and zero sequences
- Transient reactance (Xd’)
- Synchronous reactance (Xd)
- Sub transient time constant (Td’’)
- Transient time constant (Td)

- DC time constant (Tdc)
- Decrement curve

3. Engine and generator material composition and construction.

4. Standard manufacturer's printed warranty statement of the engine and generator set showing single source responsibility by the engine manufacturer.

5. Generator control panel equipment and features. Include a written explanation of the auto start/stop logic and operation.

6. Engine-generator set and accessory catalog data sheets including, but not limited to, the vibration isolators, flexible exhaust coupling, exhaust silencer, batteries, battery charger, main line circuit breaker and enclosure, circuit breaker trip units, engine manufacturers shutdown contactors, fuel lines, fuel level devices, jacket coolant heater, generator strip heater, fuel tank(s) and pump(s). Include radiator data sheets describing the materials of construction for the radiator core, fan and frame. Include a detailed statement concerning non-engine-generator set manufacturer's warranty policies, Dealer's responsibility, and duration of policy.

7. Standard dealer preventative maintenance contract for review and possible adoption under a separate contract. Dealer must have existing contracts and personnel and contractual detailed performance information available.

8. Normal operating ranges for systems temperature, pressure and speed.

9. Manufacturer's part number for the engine and generator operation guide, parts book, service manual, warranty policy, and installation guide.

10. Location of other similar units.

11. Phone numbers of twenty-four (24) hour products support contacts and locations.

12. Drawing showing right hand, left hand, and top views of proposed assembly; battery rack, isolators, exhaust silencer, conduit stub up locations, and flexible fittings; wiring schematics, interconnection diagrams (point to point), and written description of engine generator controls and alarm circuits.

13. Control panel layout drawings and wiring diagrams.

14. Drawings and specifications for base-mounted fuel storage tank with accessories and leak detection system.

15. Detailed drawings showing plan, front, and side views as well as appropriate section views of the weatherproof, engine-generator enclosure. Include product data sheets for all appurtenances (e.g. exhaust fan, thermostat, lighting, switches, receptacles, panelboard, etc.) to be furnished and installed in the enclosure. Drawings shall be of sufficient detail to assure proper installation by the Subcontractor.

D. The shop drawing information shall be complete and organized in such a way that the Design/Builder can determine if the requirements of these Specifications are being met. Copies of technical bulletins, technical data sheets from "soft-cover" catalogs, and similar

information which is "highlighted" or somehow identifies the specific equipment items the Subcontractor intends to provide are acceptable and shall be submitted.

1.06 OPERATION AND MAINTENANCE MANUALS

A. The Subcontractor shall submit operation and maintenance manuals in accordance with the procedures and requirements set forth in the General Conditions and Division 1.

B. Furnish identical bound instruction manuals (quantities as defined in Division 1) covering operating procedures, lubrication, and maintenance requirements of all equipment furnished under this Item. Include wiring diagrams, drawings, product data sheets, parts lists, and other necessary data. Number or otherwise clearly identify all parts to facilitate ordering of replacements. Exclude data not pertinent to this installation.

1.07 TOOLS, SUPPLIES, AND SPARE PARTS

A. The engine-generator systems shall be furnished with all special tools necessary to disassemble, service, repair and adjust the equipment as part of a regular maintenance program. All spare parts as recommended by the equipment manufacturer shall be furnished to the Owner by the Subcontractor.
The Subcontractor shall furnish the following spare parts for each engine-generator set:

| No. Required | Description |
|---|---|
| 1 | Set of Fuel Oil Filters |
| 1 | Set of Air Filters |
| 1 | Set of Lube Oil Filters |
| 1 | Set of Fuel Oil/Water Separator Filters |

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. Spare parts shall be delivered at the same time as the equipment to which they pertain. The Subcontractor shall properly store and safeguard such spare parts until completion of the work, at which time they shall be delivered to the Owner.

D. Spare parts list, included with the shop drawing submittal, shall indicate specific sizes, quantities, and part numbers of the items to be furnished. Terms such as "1 lot of packing material" are not acceptable.

E. Parts shall be completely identified with a numerical system to facilitate parts inventory control and stocking. Each part shall be properly identified by a separate number. Those parts which are identical for more than one size, shall have the same parts number.

F. The dealer shall have sufficient parts inventory to maintain over-the-counter availability of at least 90% of any required part and 100% availability within 48 hours.

1.08 SERVICE OF MANUFACTURER'S REPRESENTATIVE

A. The Subcontractor shall provide the services of a qualified manufacturer's factory-trained technical representative who shall adequately supervise the installation and testing of all equipment furnished under this Contract and instruct the Subcontractor's personnel and the

Owner's operating personnel in its maintenance and operation as outlined elsewhere in Division 1 and Section 11000, Equipment - General Provisions. The services of the manufacturer's representative shall be provided for a period of not less than as follows:

1. One trip of three (3) working days during installation of the equipment for each engine-generator system.

2. One trip of one (1) working day after acceptance of the equipment.

3. One trip of one (1) working day during the warranty period.

B. Any additional time required to achieve successful installation and operation shall be at the expense of the Subcontractor. The manufacturer's representative shall sign in and out at the office of the Design/Builder's Field Representative on each day he is at the project.

C. The engine-generator set manufacturer shall have a local authorized dealer who can provide factory trained service, the required stock of replacement parts, technical assistance, and warranty administration for all components supplied by the dealer.

1.09 IDENTIFICATION

A. Each engine-generator set shall be identified with the identification number indicated on the Drawings. A nameplate shall be securely affixed in a conspicuous place on the generator main circuit breaker enclosure. Nameplates shall be as specified in Section 16195, Electrical - Identification.

1.10 TRAINING

A. The Subcontractor shall provide training for Owner personnel. Training shall be conducted by the manufacturer's factory trained specialists who shall instruct Owner personnel in operation and maintenance of all equipment provided under this Section. Training shall be in accordance with the requirements of Section 11000, Equipment-General Provisions.

1.11 WARRANTY TERMS

A. The manufacturer's and dealer's standard warranty shall in no event be for a period of less than two (2) years or two-thousand (2,000) hours of operation, whichever comes first, from date of initial start-up of the system and shall include repair labor, travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Submittals received without written warranties as specified shall be rejected in their entirety.

1.12 SOUND ATTENUATION

A. Extreme care shall be exercised in providing equipment for and setting the engine-generator in place to guard against excessive noise transmission and vibrations. Fasten to the underside of the skids seismically-rated spring type isolators.

B. The engine-generator enclosure shall be designed, furnished, and installed in a weather-protected, sound-attenuated Level II enclosure provided to reduce source noise to 76 dB(A) as measured at seven (7) meters from the enclosure.

1.13 OIL SAMPLING SERVICE

A. The generator set supplier shall provide an oil sampling analysis kit which operating personnel shall utilize for scheduled oil sampling. All equipment needed to take oil samples shall be provided in a kit and shall include the following:

| | |
|---|---|
| 1 | Sample extraction gun |
| 10 | Bottles |
| 10 | Postage-paid mailers |
| 1 | Written instructions |

An additional oil sampling kit shall be made available to the Owner to continue the sampling when the above specified kit has been depleted. All kits in addition to that specified above shall be at an additional cost to the Owner, if the Owner desires to continue the sampling service.

PART 2 -- PRODUCTS

2.01 MANUFACTURERS

A. The equipment covered by this Specification is intended to be standard equipment of proven performance as manufactured by reputable concerns. Equipment shall be designed, constructed and installed in accordance with the best practices of the trade, and shall operate satisfactorily when installed as shown on the Drawings.

B. The engine-generator set manufacturers shall be Cummins/ONAN, Caterpillar, or Kohler. The engine-generator set manufacturer shall be responsible for the entire engine-generator package including the engine-generator set with enclosure, fuel system, accessories, electrical equipment, and other devices for a complete and operable system.

2.02 GENERAL DESCRIPTION

A. The engine-generator set shall be rated as specified herein and as indicated on the Drawings. It shall have the capability to operate at its standby rating for the duration of any power outage with all accessories including engine running devices, silencer, radiator, cooling fans, fuel system, and all appurtenances complete as it would be installed in the field.

B. The engine-generator set shall be capable of normal operation during and after seismic loading. Seismic loading shall not cause false operation. Reference Specification Section 01350 – Seismic Anchorage and Bracing and the Seismic Load requirements on Structural Drawing S1.

2.03 ENGINE

A. The engine shall be diesel, 4 cycle, radiator cooled, and shall be turbocharged having an operating speed of 1800 RPM. Engine shall operate on No. 2 diesel fuel. Engines requiring premium fuels are not acceptable.

B. The engine will not be acceptable if the design is a conversion of a naturally aspirated engine to which a turbo-blower has been attached.

C. Break mean effective pressure (BMEP) shall not exceed 350 psi at rated load. Brake Horsepower (BHP), and Engine-Generator efficiency shall conform with ASME, IEEE and NEMA standards that electrical energy delivered by the machine is within the minimum certified guaranteed fuel oil consumption rate and evidence that these parameters have been met shall be furnished.

D. Routine maintenance and adjustments shall be performed without the use of special tools or instruments. Only engine manufacturers' standard ratings shall be acceptable. No dealer special ratings will be acceptable.

E. The specified standby kW rating shall be for continuous electrical service during interruption of the normal utility source, per NEMA standards.

F. Engine speeds shall be governed by an electronic isochronous governor that will sense generator speed and provide accurate load transient correction capability at less than 0.5 percent regulation, from no load to full load generator output.

G. The engine shall have a 24 volt battery charging generator with an automatic charge rate regulator. Starting shall be by an electric starter.

2.04 GENERATOR

A. The generator shall conform with NEMA and IEEE standards rated as indicated on the Drawings. The generator assembly shall have a UL2200 listing. The generator shall be brushless, salient pole, 2/3 pole pitch and synchronous for operation at 480VAC, wye connected, solidly grounded, as indicated on the Drawings. The generator shall be capable of at least 2,137 SkVA at no more than 20% voltage drop.

B. Laminations and windings shall be designed for minimum reactance, low voltage waveform distortion and maximum efficiency.

C. Insulation shall be Class H, 105 degrees C rise according to NEMA standards. All windings and coils shall have an additional treatment of three (3) coats of varnish to prevent fungus growth.

D. Radio interference suppression (both directions) shall be provided in accordance with NEMA and IEEE Standards.

E. The alternator shall have a brushless, permanent magnet exciter. The exciter shall supply field excitation to maintain output with the alternator loaded to 300% of continuous rating for 10 seconds at rated power factor.

F. Waveform deviation shall not exceed 5% from true sine wave. The transient response from no load to full load in one step of the engine-generator set shall not exceed a voltage dip of 35%, a frequency dip of 20%, and shall recover to complete steady state performance within 12 seconds for both voltage and frequency. The transient response from full load to no load in one step shall not exceed a voltage overshoot of 7% and shall recover to steady state performance within 3 seconds. These measurements shall be made by a light beam oscillograph recorder and shall be a result of testing the engine-generator set combination. Data on generator transient response measured on an electric motor driven generator will not be acceptable in the submittal information.

G. The Telephone Influence Factor (TIF) shall be less than 50.

H. Alternator outputs shall be certified by an independent testing laboratory. Certified test reports by the alternator manufacturer shall be submitted for approval showing compliance with the requirements of the Specifications.

I. The voltage regulator shall be an adjustable, solid-state, three-phase RMS sensing, volts/hertz type. Voltage regulation shall be a minimum of +/-0.25% from no load to continuous rating. The voltage regulator shall provide +/-10% voltage adjustment. The voltage regulator shall be located within the engine control panel.

J. A generator mounted strip heater shall be furnished and installed as part of the system. The strip heater shall be "ON" to prevent condensation when the engine generator set is not running.

2.05 CONTROLS

A. Engine-generator monitoring and controls shall be mounted in a single NEMA 1 dust-tight enclosure. A suitable accessible terminal strip having all wires properly identified shall be furnished. The panel shall include a local engine failure alarm, a dry contact for remote "Generator System Failure" alarm indication, and engine starting control wire. The panel shall be mounted between 4'-8" and 6' measured from the center of the panel to the equipment pad.

B. The engine starting shall be automatic and shall include a starting motor, a cranking contactor, provisions for electrically operated fuel control, and protective devices for low oil pressure, high coolant temperature, low coolant level, and overspeed conditions.

C. The automatic engine starting control shall operate from a single pole contact which closes for engine run and opens for engine stop. When the engine starts, starting control shall automatically disconnect cranking controls.

D. The cranking disconnect means shall be electrically self-regulating to prevent recranking for a definite time after source voltage has been reduced to a low value. If the engine fails to fire, or any safety device should operate while the engine is running, the engine shall be stopped immediately and the starting controls locked out requiring manual resetting.

Failure to start shall initiate an alarm signal that must be reset in order to have the alarm activated after normal power is restored. The "Failure to Start" signal shall be derived from a dry contact closure which is wired as part of a common "Generator System Failure" alarm.

E. Starting control circuits shall be arranged so that cranking will commence immediately after the single pole contact closes. Four cranking cycles of 10 seconds "ON", 10 seconds "OFF" shall be provided.

F. The automatic engine starting controls shall use industrial rated control type elements throughout, and controls shall have the capability to operate at 50% battery voltage. Indicating lamps, pushbuttons, selector switches, and other pilot devices shall be accessible and mounted on the control enclosure.

G. A molded case generator/exciter field circuit breaker with shunt trip device shall be furnished and installed as part of the engine generator set. Shunt trip shall be activated upon engine-generator fault conditions.

H. A molded case main line circuit breaker as specified herein and sized as indicated on the Drawings shall be installed as a load circuit interrupting and protection device in a NEMA 1 (gasketed) dust-tight enclosure. The circuit breakers shall be provided with adjustable long-time, short-time, and instantaneous settings. The circuit breakers shall contain an electronic trip unit with ground fault protection settings. It shall operate both manually for normal operation and automatically for protection against overload or short circuits. Generator/exciter field circuit breakers are not acceptable for this service.

The molded case circuit-breakers described above shall be manufactured and tested in accordance with U.L. and NEMA AB1 standards. Their interrupting rating shall be suitable for the available fault current. All electrical ratings shall be suitable for the application.

I. The devices necessary for automatic starting shall be on the engine and in the engine control panel.

J. Engine-generator monitoring and control shall be provided using a microprocessor based control panel complete with LCD displays. Engine-generator monitoring and control shall include, but not be limited to, the following:

1. Engine oil pressure indicator
2. Coolant temperature indicator
3. Voltmeter
4. Ammeter
5. Phase selector switch
6. Running time meter
7. Frequency meter
8. High coolant temperature shutdown, signal light (red), and dry contact with reset
9. Low oil pressure shutdown, signal light (red), and dry contact with reset
10. Engine overspeed shutdown, signal light (red), and dry contact with reset
11. Engine overcranking protection with signal light (red) and dry contact with reset (after a cranking cycle of one minute, engine cranking shall stop)
12. Engine tried to start but failed signal light (amber)
13. Low coolant level signal light (red) and dry contact
14. Engine "Run" (green) and "Fail" (red) signal lights and dry contacts

15. Low coolant temperature signal light (red) and dry contact

16. Pre-high engine temperature indication and dry contact

17. Pre-low fuel indication and dry contact

18. Engine control mode switch (Run-Off-Auto)

19. Tachometer and engine speed (RPM) indicator

20. Emergency stop pushbutton

21. Generator voltage adjust potentiometer

22. Generator frequency adjust potentiometer

23. Indicator/display test switch

24. Panel lights with On/Off switch

Engine “run” and “pre low fuel level” contacts shall be separate, independent dry contacts for remote indication.

The remaining dry contacts listed above shall be normally closed (N.C.) and wired in series to provide a "Generator System Failure" alarm for remote indication.

2.06 ENGINE ACCESSORIES

A. Furnish and install the engine with all accessory equipment and appurtenances which may be required for proper operation, including the following:

1. Dry type air cleaner

2. Engine driven lubricating oil pump

3. Lubricating oil strainer

4. Lubricating oil filter, bypass type, with replaceable absorbent-type elements

5. Lubricating oil cooler, water cooled

6. Lubricating oil cooling circulator pump (may be integral with main oil pump)

7. Fuel oil transfer pump

8. Fuel oil strainer

9. Fuel oil filter, with replaceable absorbent-type elements

10. Fuel oil fuel/water separator

11. Electronic controlled fuel injection

12. Fuel oil injection valve assemblies

13. Electronic isochronous governor

14. Safety controls, providing automatic engine shut-down, including:

    a. Overspeed control

    b. Low oil pressure control

    c. High coolant temperature control

    d. Failure to start control

    e. Low coolant level control

15. Radiator and cooling fan

16. Jacket water circulating pump

17. Thermostats

18. Water expansion tank

19. Exhaust manifold

20. Automatic battery starting system

21. Cold starting aid engine block heaters with all controls

22. Instrument panel mounted on the engine, complete with instruments, including:

    a. Lubricating oil pressure gauge

    b. Fuel oil pressure gauge

    c. Coolant temperature indicator

    d. Fuel level indicator

23. Radiator mounted fuel cooler to cool recirculated fuel before it is re-deposited into the fuel tank as recommended by the manufacturer.

2.07 MOUNTING

A. Couple the engine and generator together through a flexible, non-backlash type, all metal coupling which overcomes all normal misalignment stresses and transmits full engine torque with ample safety factor. Also provide flexible connections for piping connections.

2.08 RADIATOR

A. Provide a radiator manufactured of a non-corrosive material mounted on the engine. The radiator core shall be coated with a corrosion resistant coating. Corrosion resistant coating shall be a corrosion resistant baked phenolic coating or similar.

B. Connect the radiator to the engine internal cooling system with flexible piping.

C. The engine shall be cooled through a radiator sized to continuously maintain safe operation at full load and at 105°F outside ambient air with 50% ethylene glycol coolant. A blower type fan and low noise fan drive and controls shall be furnished. The fan and all rotating members and drive belts shall be guarded and meet OSHA standards. Proof of 105°F ambient temperature capability shall be required.

D. The unit shall be provided with 50% ethylene glycol. An engine coolant stabilizer such as Nalcool treatment shall also be added to the system in the proper proportion.

E. Unit mounted thermal circulation type water heaters shall be furnished to maintain engine jacket water temperature as recommended by manufacturer in an ambient temperature of 30°F. The heaters shall be single phase, 60 hertz, 240 volt thermostatically controlled as manufactured by Watlow Industries, Chromalox, Kim Hotstart, or equal.

2.09 ENGINE STARTING SYSTEM

A. Provide an engine starting system complete with battery charger, battery tray, and batteries.

B. The charger shall be an automatic battery charger, 10 A max, current limited, ±2% voltage regulation, ±10% line voltage variation, equalizing timer, DC voltmeter, and DC ammeter. Provide a 0-24 hour equalize timer and a Form C Dry Contact to indicate a low battery alarm condition. Charger shall be as manufactured by Charles Industries, Exide, LeMarche, or equal. The charger shall be located inside the generator enclosure.

C. Starting batteries shall be sealed, lead-acid type rated 24 volts having adequate capacity for rolling the engine for five (5), ten (10) second cycles without starting and operating the control devices in the generator panel. The batteries shall be mounted on a suitable non-corrosive rack and shall be Nife, Exide, Tudor, or equal. Batteries shall have battery cables with lugs and shall be provided with lugs for connection to the battery charger.

2.10 EXHAUST SILENCER

A. Furnish and install an exhaust silencer mounted within or exterior to the generator enclosure dependent on generator size and manufacturer's standards. Silencers mounted outside the generator enclosure shall be 316 stainless steel interior and exterior. The silencer system shall be designed, furnished, and installed to prevent moisture and condensation from corroding the silencer. Silencers mounted within the generator enclosure shall be insulated using a calcium silicate material covered by a brushed aluminum skin. All exterior components of the exhaust silencer system shall be of 316 stainless steel. The work shall result in a long-term, aesthetically pleasing installation.

B. Silencers shall be of critical type and sized to produce a high degree of silencing. Reference the sound attenuation requirements specified herein.

C. Connect the silencer to the engine exhaust manifold with a high corrosion and temperature resistant stainless steel flexible convoluted exhaust pipe. Use flange-type connections. Provide a taper-cut tail pipe complete with rain cap to exhaust the gases to the atmosphere.

D. The exhaust manifold, exhaust piping, and expansion fittings including collector box, shall be completely covered with an insulation blanket in order to protect operating personnel and to reduce noise. Insulation shall be of composite fiberglass and stainless steel construction capable of withstanding 1200°F continuously. The insulation blankets shall be tailored and custom fabricated to fit the contours of the manifolds. Average weight of the insulating blanket shall be 1.5 psf. Insulation shall conform to MIL-1-16411D, Type II and shall be custom fabricated to fit the contours of the manifold. Insulation shall be Hitco Blanket Armco, Hitco Blanket Insulation system, or equal.

2.11 WIRING

A. Furnish and set in position internal wiring in the engine-generator set under this Section. All external wiring between the generator and engine-generator control panel, the switchgear and all other components of the standby power system, including conduit and connection, shall be provided.

2.12 BASE MOUNTED FUEL TANK

A. The generator set shall be supplied with a U.L.-142 listed base mounted fuel tank of sufficient capacity to operate the engine-generator set at 80% of full load for a minimum of 48 hours. The tank, painted in a color as selected by the Design/Builder, shall be fabricated from steel with a rupture basin and leak detector system. The alarm and indicator for the leak detection shall be mounted adjacent to the generator control panel and a contact for remote indication of a fuel leak condition shall be provided. This contact shall be wired as part of a common "Generator System Failure" alarm.

B. A level device shall also be furnished and installed to provide a local (generator control panel) and remote indication of pre-low fuel tank level and low fuel tank level. The pre-low fuel tank level shall activate a set of dry contacts for remote alarm indication. The low fuel tank level alarm shall shut down the engine to prevent the fuel level from dropping below the fuel pickup piping in the fuel tank. The pre-low fuel level alarm shall activate when only 6 hours of fuel for full load operation remains in the fuel tank. The remote low fuel tank level alarm shall be wired separate from the "Generator System Failure" alarm.

C. The tank shall be supplied with all necessary fuel supply, return, vent, and fill fittings and a fuel level gauge. The lockable fill port and level gauge shall be easily accessible from outside the enclosure. The vent line shall be piped to the outside and be equipped with a fill whistle.

D. The system shall be equipped with a radiator mounted fuel cooler, which shall remove all heat added to fuel in the recirculation process at a 105°F ambient.

E. The underside of the tank shall not be in contact with the mounting surface (concrete pad).

2.13 WEATHERPROOF ENGINE - GENERATOR ENCLOSURE

A. Furnish and install an outdoor, weather-protective, sound-attenuated housing. The housing shall be furnished complete with a full sub-base floor resulting in complete enclosure. The

enclosure shall be factory-assembled to the engine-generator set base and radiator cowling. Lifting eyes shall be provided. Housing shall provide ample airflow for generator set operation. The housing shall be constructed of 12 gauge (minimum) aluminum or 14 gauge (minimum) galvanized steel, reinforced to be vibration free in the operating mode. The housing shall have hinged side-access doors and rear control panel access door. Each door shall have at least two latch-bearing points. All doors shall be lockable. All steel sheet metal shall be primed for corrosion protection and finish painted in a color as selected by the Owner. Roof shall be peaked to allow drainage of rain water. Unit shall have sufficient guards to prevent entrance by small animals. Batteries shall fit inside enclosure and alongside the engine (batteries under the generator are not acceptable). Unit shall have engine coolant and oil drains outside the unit to facilitate maintenance. Each drain line shall have a high quality valve located near the fluid source. All hardware external to the enclosure shall be 316 stainless steel. Galvanized hardware is not acceptable.

B. A “Skin-tight” weather-protective, sound-attenuated housing shall be provided. No walk-around access is required within the enclosure.

C. The enclosure shall be furnished with a dry type step-down transformer and panelboard. This panelboard shall serve as the power distribution panel for all accessories specified herein and as required (e.g. space heaters, battery charger, leak detection system, etc.). All accessories shall be factory prewired to the power distribution panel via contactors or other control devices as required. The Subcontractor shall furnish and install all conduit and wire necessary to provide the power supply to the transformer. Refer to Section 16461 – Dry Type Distribution Transformers and Section 16470 – Panelboards.

D. Enclosure shall be sound attenuated to provide sound level as specified herein.

E. Fluorescent lighting shall be provided in sufficient quantity to maintain 20 foot-candles of illumination at floor level and shall be suitable for operation in cold weather. Fixtures shall be Holophane Type EMS with 4’ T8 lamps and program start ballasts. Interior lighting shall be controlled by 3-way light switches located at each door, one switch per side.

F. Convenience receptacles shall be furnished at each door within the enclosure. Receptacles shall be 125V, 20A, two-pole, three wire ground fault type with “in-use” weather protected cover plates.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. The standby generator system shall be furnished and installed as indicated on the Drawings and as recommended by the equipment manufacturer.

B. After successful completion of all field testing and immediately prior to final inspection, the Subcontractor shall fill the fuel tank(s) and all other fluid levels to their capacity for the standby power system.

### 3.02 RUBBER MATS

A. A three foot wide rubber mat shall be furnished and installed on the floor and in front of the control panel and the main line circuit breaker. The mat shall be long enough to cover the full length of the equipment. The mat shall be 1/4 inch thick with beveled edges, canvas

back, solid type with corrugations running the entire length of the mat. The mat shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mat shall meet OSHA requirements and the requirements of ANSI/ASTM D-178 J6-7 for Type 2, Class 2 insulating matting.

- END OF SECTION -

SECTION 17000

CONTROL AND INFORMATION SYSTEM
SCOPE AND GENERAL REQUIREMENTS

## PART 1 -- GENERAL

### 1.01 SCOPE

A. The Subcontractor shall provide all components, system installation services, as well as all required and specified ancillary services in connection with the Instrumentation, Control and Information System. The System includes all materials, labor, tools, fees, charges and documentation required to furnish, install, test and place in operation a complete and operable instrumentation, control and information system as shown and/or specified. The system shall include all measuring elements, signal converters, transmitters, local control panels, PLC digital hardware and software, signal and data transmission systems, and such accessories as shown, specified, and/or required to provide the functions indicated.

B. The scope of the work to be performed under this Division includes but is not limited to the following:

1. The Subcontractor shall retain overall responsibility for the instrumentation and control system as specified herein.

2. Furnish and install process instrumentation and associated taps and supports as scheduled or shown on the Drawings, unless otherwise noted or supplied by equipment vendors.

3. Furnish and integrate local control panels, field panels and associated cabinets and panels as shown on the Drawings and as specified in Division 17.

4. Furnish and install PLC digital control system hardware and software as specified in Division 17.

5. Provide the final termination and testing of all instrumentation and control system signal wiring and power supply wiring at equipment furnished under Division 17.

6. Furnish, install and terminate all instrument cables and furnish and terminate data highway network cables.

7. Furnish and install surge protection devices for all digital equipment, local control panels, and instrumentation provided under this Division, including connections to grounding system(s) provided under Division 16.

8. Integration of all vendor supplied PLCs into the plant communication network. This includes the creation of SCADA HMI screens for the vendor supplied systems.

9. Coordinate grounding requirements with the electrical subcontractor for all digital equipment, local control panels, and instrumentation provided under this Division. Terminate grounding system cables at all equipment provided under this Division.

10. Provide system testing, calibration, training and startup services as specified herein and as required to make all systems fully operational.

C. It is the intent of the Contract Documents to construct a complete and working installation. Items of equipment or materials that may reasonably be assumed as necessary to accomplish this end shall be supplied whether or not they are specifically stated herein.

1.02 RELATED ITEMS

A. Field mounted switches, torque switches, limit switches, gauges, valve and gate operator position transmitters, sump pump controls and other instrumentation and controls furnished with mechanical or electrical equipment not listed in the instrument schedule shall be furnished, installed, tested and calibrated as specified under other Divisions.

B. Additional and related work performed under Division 16 includes the following:

1. Instrument A.C. power source and disconnect switch for process instrumentation, A.C. grounding systems, and A.C. power supplies for all equipment, control panels and accessories furnished under Division 17.

2. Conduit and raceways for all instrumentation and control system signal wiring, grounding systems, special cables and data highway cables.

3. Instrumentation and control system signal wiring.

4. Furnish, install and provide terminations for all data highway network cables.

5. Furnish and install grounding systems for all digital equipment, local control panels, and instrumentation provided under Division 17. Grounding systems shall be complete to the equipment provided under Division 17, ready for termination by the instrumentation subcontractor.

6. Termination of all instrumentation and control system signal wiring at all equipment furnished under other divisions of the Specifications.

7. Final wiring and termination to A.C. grounding systems and to A.C. power sources (e.g. panelboards, motor control centers, and other sources of electrical power).

1.03 GENERAL INFORMATION AND DESCRIPTION

A. Where manufacturers are named for a particular item of equipment, it is intended as a guide to acceptable quality and performance and does not exempt such equipment from the requirements of these Specifications or Drawings.

B. In order to centralize responsibility, it is required that all equipment (including field instrumentation and control system hardware and software) offered under this Division shall be furnished and installed by the instrumentation subcontractor, or under the supervision of the instrumentation subcontractor, who shall assume complete responsibility for proper operation of the instrumentation and control system equipment, including that of coordinating all signals, and furnishing all appurtenant equipment.

C. The Subcontractor shall retain total responsibility for the proper detailed design, fabrication, inspection, test, delivery, assembly, installation, activation, checkout, adjustment and operation of the entire instrumentation and control system as well as equipment and controls furnished under other Divisions of the Specifications. The Subcontractor shall be responsible for the delivery of all detailed drawings, manuals and other documentation required for the complete coordination, installation, activation and operation of mechanical equipment, equipment control panels, local control panels, field instrumentation, control systems and related equipment and/or systems and shall provide for the services of a qualified installation engineer to supervise all activities required to place the completed facility in stable operation under full digital control.

D. The instrumentation and control system shall be capable of simultaneously implementing all real-time control and information system functions, and servicing all operator service requests as specified, without degrading the data handling and processing capability of any system component. It shall also be possible to simultaneously generate displays on all workstations and print out data on all printers without degradation of system performance.

E. Control system inputs and outputs are listed in the Input/Output Schedule. This information, together with the control strategy descriptions, process and instrumentation diagrams, and electrical control schematics, describes the real-time monitoring and control functions to be performed. In addition, the system shall provide various man/machine interface and data reporting functions as specified in the software sections of this Specification.

F. The mechanical, process, and electrical drawings indicate the approximate locations of field instruments, control panels, systems and equipment as well as field-mounted equipment provided by others. The instrumentation subcontractor shall examine the mechanical, process and electrical drawings to determine actual size and locations of process connections and wiring requirements for instrumentation and controls furnished under this Contract. The instrumentation subcontractor shall inspect all equipment, panels, instrumentation, controls and appurtenances either existing or furnished under other Divisions of the Specifications to determine all requirements to interface same with the control and information system. The Subcontractor shall coordinate the completion of any required modifications with the associated supplier of the item furnished.

G. The instrumentation subcontractor shall review and approve the size and routing of all instrumentation and control cable and conduit systems furnished by the electrical subcontractor for suitability for use with the associated cable system.

H. The Subcontractor shall coordinate the efforts of each supplier to aid in interfacing all systems. This effort shall include, but shall not be limited to, the distribution of approved shop drawings to the electrical subcontractor and to the instrumentation subcontractor furnishing the equipment under this Division.

I. The Subcontractor shall be responsible for providing a signal transmission system free from electrical interference that would be detrimental to the proper functioning of the instrumentation and control system equipment.

J. The Owner shall have the right of access to the subcontractor's facility and the facilities of his equipment suppliers to inspect materials and parts; witness inspections, tests and work in progress; and examine applicable design documents, records and certifications during any stage of design, fabrication and tests. The instrumentation subcontractor and his equipment suppliers shall furnish office space, supplies and services required for these surveillance activities.

K. The terms "Instrumentation", "Instrumentation and Control System", and "Instrumentation, Control and Information System" shall hereinafter be defined as all equipment, labor, services and documents necessary to meet the intent of the Specifications.

1.04 INSTRUMENTATION AND CONTROL SYSTEM SUBCONTRACTORS

A. Instrumentation and control system subcontractors shall be regularly engaged in the detailed design, fabrication, installation, and startup of instrumentation and control systems for water treatment facilities.

B. Instrumentation and control system subcontractors shall have a minimum of five years of such experience, and shall have completed a minimum of three projects of similar type and size as that specified herein. Where specific manufacturers and/or models of major hardware or software products (PLC, HMI software, LAN, etc.) are specified to be used on this project, the instrumentation and control system subcontractor shall have completed at least one project using that specified hardware or software. As used herein, the term “completed” shall mean that a project has been brought to final completion and final payment has been made. Any instrumentation and control system subcontractor that has been subject to litigation or the assessment of liquidated damages for nonperformance on any project within the last five calendar years shall not be acceptable.

C. Acceptable instrumentation and control system subcontractors shall be LangeTech, Inc.

1.05 DEFINITIONS

A. Solid State: Wherever the term solid state is used to describe circuitry or components in the Specifications, it is intended that the circuitry or components shall be of the type that convey electrons by means of solid materials such as crystals or that work on magnetic principles such as ferrite cores. Vacuum tubes, gas tubes, slide wires, mechanical relays, stepping motors or other devices will not be considered as satisfying the requirements for solid state components of circuitry.

B. Bit or Data Bit: Whenever the terms bit or data bit are used in the Specification, it is intended that one bit shall be equivalent to one binary digit of information. In specifying data transmission rate, the bit rate or data bit rate shall be the number of binary digits transmitted per second and shall not necessarily be equal to either the maximum pulse rate or average pulse rate.

C. Integrated Circuit: Integrated circuit shall mean the physical realization of a number of circuit elements inseparably associated on or within a continuous body to perform the function of a circuit.

D. Mean Time Between Failures (MTBF): The MTBF shall be calculated by taking the number of system operating hours logged during an arbitrary period of not less than six months and dividing by the number of failures experienced during this period plus one.

E. Mean Time to Repair (MTTR): The MTTR shall be calculated by taking the total system down time for repair over an arbitrary period of not less than six months coinciding with that used for calculation of MTBF and dividing by the number of failures causing down time during the period.

F. Availability: The availability of a nonredundant device or system shall be related to its MTBF and MTTR by the following formula:

A = 100 x (MTBF/(MTBF + MTTR)) Percent

The availability of a device or system provided with an automatically switched backup device or system shall be determined by the following formula:

A = A2 + 1 - ((1-A1) x (1-A1))

where:

A1 = availability of nonredundant device or system
A2 = availability of device or system provided with an automatically switched backup device or system

G. Abbreviations: Specification abbreviations include the following:

| | | |
|---|---|---|
| A | - | Availability |
| ADC | - | Analog to Digital Converter |
| AI | - | Analog Input |
| AO | - | Analog Output |
| AVAIL | - | Available |
| BCD | - | Binary Coded Decimal |
| CSMA/CD | - | Carrier Sense Multiple Access/Collision Detect |
| CPU | - | Central Processing Unit |
| CRC | - | Cyclic Redundancy Check |
| CRT | - | Cathode Ray Tube |
| CS | - | Control Strategy |
| DAC | - | Digital to Analog Converter |
| DBMS | - | Data Base Management System |
| DI | - | Discrete Input |
| DMA | - | Direct Memory Access |
| DO | - | Discrete Output |
| DPDT | - | Double Pole, Double Throw |
| DVE | - | Digital to Video Electronics |
| EPROM | - | Erasable, Programmable Read Only Memory |
| FDM | - | Frequency Division Multiplexing |
| FSK | - | Frequency Shift Keyed |
| HMI | - | Human Machine Interface (Software) |
| I/O | - | Input/Output |
| LAN | - | Local Area Network |

| | | |
|---|---|---|
| LDFW | - | Lead-Follow |
| MCC | - | Motor Control Center |
| MTBF | - | Mean Time Between Failures |
| MTTR | - | Mean Time To Repair |
| OS | - | Operating System |
| PCB | - | Printed Circuit Board |
| PID | - | Proportional Integral and Derivative Control |
| PLC | - | Programmable Logic Controller |
| PROM | - | Programmable Read Only Memory |
| RAM | - | Random Access Memory |
| RDY | - | Ready |
| RMSS | - | Root Mean Square Summation |
| RNG | - | Running |
| ROM | - | Read Only Memory |
| RTU | - | Remote Telemetry Unit |
| SPDT | - | Single Pole, Double Throw |
| ST/SP | - | Start/Stop |
| TDM | - | Time Division Multiplexing |
| UPS | - | Uninterruptible Power Supply |

H. To minimize the number of characters in words used in textual descriptions on CRT displays, printouts and nameplates, abbreviations may be used subject to the Engineer's approval. If a specified abbreviation does not exist for a particular word, an abbreviation may be generated using the principles of masking and or vowel deletion. Masking involves retaining the first and last letters in a word and deleting one or more characters (usually vowels) from the interior of the word.

1.06 ENVIRONMENTAL CONDITIONS

A. Instrumentation equipment and enclosures shall be suitable for ambient conditions specified. All system elements shall operate properly in the presence of telephone lines, power lines, and electrical equipment.

B. Inside control rooms and climate-controlled electrical rooms, the temperature will normally be 20 to 25 degrees C; relative humidity 40 to 80 percent without condensation and the air will be essentially free of corrosive contaminants and moisture. Appropriate air filtering shall be provided to meet environmental conditions (i.e., for dust).

C. Other indoor areas may not be air conditioned/heated; temperatures may range between 0 and 40 degrees C with relative humidity between 40 and 95 percent.

D. Field equipment including instrumentation and panels may be subjected to wind, rain, lightning, and corrosives in the environment, with ambient temperatures from -20 to 40 degrees C and relative humidity from 10 to 100 percent. All supports, brackets and

interconnecting hardware shall be aluminum or 316 stainless steel as shown on the installation detail drawings.

## PART 2 -- PRODUCTS

### 2.01 NAMEPLATES

A. All items of equipment listed in the instrument schedule, control panels, and all items of digital hardware shall be identified with nameplates. Each nameplate shall be located so that it is readable from the normal observation position and is clearly associated with the device or devices it identifies. Nameplates shall be positioned so that removal of the device for maintenance and repair shall not disturb the nameplate. Nameplates shall include the equipment identification number and description. Abbreviations of the description shall be subject to the Engineer's approval.

B. Nameplates shall be made of 1/16-inch thick machine engraved laminated phenolic plastic having white numbers and letters not less than 3/16-inch high on a black background.

C. Nameplates shall be attached to metal equipment by stainless steel screws and to other surfaces by an epoxy-based adhesive that is resistant to oil and moisture. In cases where the label cannot be attached by the above methods, it shall be drilled and attached to the associated device by means of stainless steel wire.

## PART 3 -- EXECUTION

### 3.01 SCHEDULE OF PAYMENT

A. Payment to the Subcontractor for Control and Information System materials, equipment, and labor shall be in accordance with the General and Supplementary Conditions. The schedule of values submitted as required by the General and Supplementary Conditions shall reflect a breakdown of the work required for completion of the Control and Information System. The breakdown shall include sufficient detail to permit the Engineer to administer payment for the Control and Information System as outlined below.

B. The following payment schedule defines project milestones that will be used for establishing maximum partial payment amounts for the Control and Information System. Payment for field instruments, field wiring, fiber optic network cable and similar items will be made in addition to the payment for the scopes of services incorporated into the schedule below.

| **Task Completed** | **Maximum Cumulative % Request for Payment** |
|---|---|
| Mobilization | 3% |
| Preliminary Design Review | 5% |
| Approved Submittals | 20% |
| Hardware Purchase (excludes field instruments) | 40% |
| Factory Acceptance Test | 60% |
| Loop Checkout | 70% |
| Control System Start-up and Test | 80% |

| | |
|---|---|
| Plant Start-up | 90% |
| Final System Acceptance Test | 95% |
| Final Acceptance | 100% |

C. Requests for payment for materials and equipment that are not installed on site, but are required for system construction and the factory acceptance test (e.g., digital hardware), or are properly stored as described in the General and Supplementary Conditions and herein, shall be accompanied by invoices from the original supplier to the instrumentation subcontractor substantiating the cost of the materials or equipment.

D. Any balance remaining within the schedule of values for field instruments and other materials installed on the site, or for other materials for which payment is made by invoice, will be considered due upon completion of the Final Acceptance test.

3.02 CLEANING

A. The Subcontractor shall thoroughly clean all soiled surfaces of installed equipment and materials.

B. Upon completion of the instrumentation and control work, the Subcontractor shall remove all surplus materials, rubbish, and debris that has accumulated during the construction work. The entire area shall be left neat, clean, and acceptable to the Owner.

3.03 FINAL ACCEPTANCE

A. Final acceptance of the Instrumentation, Control and Information System will be determined complete by the Engineer, and shall be based upon the following:

1. Receipt of acceptable start up completion and availability reports and other documentation as required by the Contract Documents.

2. Completion of the Availability Demonstration

3. Completion of all punch-list items that are significant in the opinion of the Engineer.

B. Final acceptance of the System shall mark the beginning of the extended warranty period.

- END OF SECTION -

# SECTION 17600

# UNPOWERED INSTRUMENTS, GENERAL

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The instrumentation subcontractor shall furnish, install, test and place in operation process instrumentation (flow elements, pressure switches, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process controls as shown on the Drawings and as specified. The Contractor may elect to install primary elements (flowmeters, etc.) on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

C. Section 17698 – Instrumentation and Control System Accessories

D. Section 17700 – Powered Instruments, General

E. Section 17800 – Analytical Instruments, General

F. Unpowered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

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### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050.

B. In addition to the above requirements, the instrumentation subcontractor shall provide spare parts as specified in individual instrument specification sections.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

A. Unless otherwise specified, instruments shall be provided with enclosures to suit specified environmental conditions. Field-mounted devices shall be rugged and mounted on walls or pipe stanchions.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and Shop Drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

B. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

C. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

D. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

E. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

### 3.02 ADJUSTMENT AND CLEANING

A. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Owner, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

B. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation and control system.

D. Field instrument calibration requirements shall conform to the following:

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

- END OF SECTION -

SECTION 17611

VENTURI FLOW TUBES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all venturi flow tubes, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 09900 – Painting

B. Section 17000 – Control and Information System Scope and General Requirements

C. Section 17600 – Unpowered Instruments, General

D. Section 17760 – Pressure Indicating Transmitters

1.03 SUBMITTALS

A. The manufacturer shall provide data that substantiates headloss and accuracy for the flow tubes submitted, which shall include the following information:

1. Differential vs. flow curves.

2. Differential vs. flow data in tabular format.

3. Non-recoverable head loss data.

4. A certified dimensional drawing for each flow tube.

5. Specific equations for calculating airflow in scfm or liquid flow in gpm, as appropriate, in the following format:

$$\text{Actual scfm} = \text{constant} \times \frac{(\text{Differential P})^{1/2} \times (\text{Operating Press.})^{1/2}}{(\text{Operating Temp.})^{1/2}} \quad \text{(Gas)}$$

$$\text{gpm (or mgd)} = \text{constant} \times (\text{Differential P})^{1/2} \quad \text{(Liquid)}$$

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B. Two copies of each of the following curves with plastic see-through type envelopes shall be furnished for each venturi tube by the manufacturer:

1. Certified differential pressure vs. flow at nominal static pressures.

2. For airflow, flow coefficient vs. pressure for above curves for a pressure range of ±3 psig from the nominal static pressures.

## PART 2 -- PRODUCTS

### 2.01 VENTURI FLOW TUBES

A. The Contractor shall furnish the exact internal diameter of process piping to the instrumentation subcontractor for fabricating and calibrating flow tubes. Unless otherwise specified, venturi tubes shall have ANSI flanged end connections. The flow tube and its end connections shall have pressure ratings at least equal to the surrounding piping. The Contractor shall coordinate end conditions for installation allowing for future removal of the tube by use of expansion fittings and flanges in the pipeline.

B. Venturi flow tubes shall produce a differential pressure proportional to the square of flow. venturi tubes shall be “universal type”, short design, of close grain, high tensile strength, cast iron construction. The inlet section shall be cylindrical and shall be the same nominal diameter as the process pipe. The high-pressure taps shall be installed in the inlet section. The venturi meter shall have a cylindrical, precision-machined, 304 stainless steel throat section with a minimum length equal to 0.5 times its diameter. The low-pressure taps shall be installed in the throat section. The outlet cone shall be truncated and shall have a maximum included angle of 10 degrees.

C. Venturi tubes shall be furnished complete with two high pressure taps, two low-pressure taps, one vent tap with plug, one drain tap with plug and one inspection port. Pressure taps shall be ½-inch or ¼-inch as recommended by the manufacturer, constructed of 316L stainless steel. If ¼-inch taps are furnished, appropriate fittings shall be provided to connect to the ½-inch process tubing. Flushing/drain assemblies with stainless steel ball valves for isolation, together with fittings and appurtenances shall be furnished on all high and low pressure taps.

D. The tube discharge coefficient shall be constant and shall be greater than or equal to 0.99 for pipe Reynolds numbers in excess of 75,000 for each specified size venturi tube. For application Reynolds numbers less than 75,000, the manufacturer shall submit actual test data substantiating the effect on meter accuracy. Accuracy shall be + or - 0.50% of actual flow rate over the specified flow range.

E. The tubes shall have a maximum permanent head loss of less than 10 percent of the maximum differential pressure.

F. Prior to shipment, interior and exterior cast iron surfaces shall receive two coats of factory applied epoxy paint with a dry film thickness of not less than 6.0 mils.

G. The venturi flow tubes shall be Model HVT-CI as manufactured by Primary Flow Signal, Inc., BIF Products or Badger Meter.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All venturi meters and appurtenant work, including pressure taps, shall be installed in strict accordance with the manufacturer's printed instructions.

B. Refer to Section 17600, Part 3 for additional requirements.

- END OF SECTION -

SECTION 17650

PRESSURE GAUGES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure gauges, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Unpowered Instruments, General

C. Section 17698 – Instrumentation Accessories

## PART 2 -- PRODUCTS

### 2.01 PRESSURE GAUGES

A. All gauges shall be designed in accordance with the ASME B40.1 entitled, "Gauges, Pressure, Indicating Dial Type - Elastic Element".

B. All gauges shall be direct reading type. Snubbers shall be provided on all gauges. Gauge full-scale pressure range shall be selected such that the maximum operating pressure shall not exceed the approximately 75% of the full-scale range.

C. Features

1. Mounting: ½” NPT, lower stem mount type
2. Accuracy: 0.5% full scale
3. Case: Solid front, black phenolic material
4. Dial: White background and black letters
5. Glass: Shatterproof
6. Blow-out protection: Back
7. Pressure element: stainless steel bourdon tube
8. Movement: Stainless steel, Teflon coated pinion gear and segment
9. Gaskets: Buna-N

D. Liquid-filled or equivalent mechanically-damped gauges shall be used if the gauges are installed with pumps, or where gauges are subjected to vibrations or pulsation. Filling fluid shall be silicone unless oxidizing agents such as sodium hypochlorite are present, where halocarbon shall be used.

E. Gauge size shall be 2" for line sizes up to 3" and 4½" for line sizes of 4" or greater.

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F. Diaphragm seals and isolating ring seals shall be furnished in accordance with the requirements specified under Section 17698 - Instrumentation and Control System Accessories.

G. The complete gauge assembly and appurtenances shall be fully assembled and tested prior to field mounting. A ½" isolation stainless steel ball valve shall be provided for each gauge assembly.

H. Pressure and vacuum gauges shall be Ashcroft Duragauge Model 1279, Ametek-U.S. Gauge Division, H.O. Trerice Co., WIKA Instrument Corporation, or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3.

- END OF SECTION -

# SECTION 17670

# LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the float level switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17600 – Unpowered Instruments, General

## PART 2 -- PRODUCTS

### 2.01 LEVEL SWITCHES (SUSPENDED FLOAT TYPE)

A. Level switches of the direct acting float-operated design shall be comprised of a hermetically sealed, approximately 5 inch diameter plastic casing float, containing microswitches and flexibly supported by means of a heavy neoprene or PVC jacket, with three conductor cable a minimum of 20 feet in length. Unless otherwise specified, media specific gravity is 0.95 to 1.05. Microswitches shall be one normally open and one normally closed, 5A-115V AC capacity. Float hangers and supports shall be provided as shown on the installation detail drawings. Float switches shall be Model ENM as manufactured by Flygt, or equal.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

A. Refer to Section 17600, Part 3 of the specifications.

- END OF SECTION -

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SECTION 17675

PRESSURE SWITCHES

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the pressure switches, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17600 - Unpowered Instruments, General

## PART 2 -- PRODUCTS

### 2.01 PRESSURE SWITCHES

A. Pressure, vacuum, and differential pressure switches shall be single or dual action with an adjustable setpoint for the process requirement and/or as specified herein. Switches shall be diaphragm or piston operated and activate S.P.D.T. snap action switches on increasing or decreasing pressure. Minimum differential shall be less than 10 percent of the range. Deadband shall be adjustable. Allowable surge pressure shall be a minimum 1.5 times the range. Each pressure switch shall have visible scale.

B. Pressure switches shall have a contact rating of 10 amperes at 120 volts AC. Pressure switches shall be in NEMA 4X enclosures. Switches shall have a repeatable accuracy of 1 percent of range. Pressure switches shall be isolated from the process fluid by a diaphragm seal or an isolation ring in locations as shown on the Contract Drawings and/or as specified. Wetted parts materials shall be compatible with the process fluid for corrosion resistance. Pressure switches shall be manufactured by ASCO, Ashcroft, or equal.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

A. Refer to Section 17600 Part 3.

- END OF SECTION -

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SECTION 17700

POWERED INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The instrumentation subcontractor shall furnish, install, test and place in operation powered process instrumentation (flow elements, level transmitters, etc.) as scheduled herein together with all signal converters, transmitters, isolators, amplifiers, etc. to interface all instrumentation, panels, controls and process equipment control panels with the process control system as shown on the Drawings and as specified. Powered instruments are those instruments that require power (120 VAC or 24 VDC loop power) to operate. The Contractor may elect to install primary elements (flowmeters, etc.) on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated transmitters, indicators, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Division where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instrumentation furnished under this Division are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage, and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

C. Section 17600 – Unpowered Instruments, General

D. Section 17698 – Instrumentation and Control System Accessories

E. Section 17800 – Analytical Instruments, General

F. Powered instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

1.03 TOOLS, SUPPLIES AND SPARE PARTS

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A. Tools, supplies and spare parts shall be provided as specified in Section 17050.

B. In addition to the above requirements, the instrumentation subcontractor shall provide one remote handheld configuration device for communication with all "smart" instruments furnished under this Contract. The devices shall be capable of performing configuration, test, and format functions from anywhere on the 4-20 mA signal loop for a particular transmitter or by direct connection. The configuration device shall be Fischer & Porter Model 50HC1000, Rosemount Model 375, or equal.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures which are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 (B) herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

## PART 3 -- EXECUTION

### 3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where the Contract Documents do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless

steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be schedule 40, 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. General

1. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration requirements for all instrumentation and controls provided under this Contract and specified herein. The Owner, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

2. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

3. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

B. Field Instrument Calibration Requirements

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. If the manufacturer's recommendations require calibration, each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

SECTION 17701

MAGNETIC FLOW METERS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17700 – Powered Instruments, General

1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one portable primary head simulator for calibration and testing of magnetic flowmeter signal converters. The calibrator shall be furnished complete with rechargeable battery pack, test leads, spare battery pack, charger, carrying case and accessories. Calibrator shall be furnished by the flowmeter manufacturer, and shall be fully matched to the instrumentation furnished.

PART 2 -- PRODUCTS

2.01 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction, and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless steel or carbon steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

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F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65°C. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of $10^9$-$10^{11}$ ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. The remote configuration device shall be as specified under Section 17700. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.50% of rate over the flow velocity range of 0.3 to 10.0 m/s. Repeatability shall be 0.1% of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than 5 uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°C. Power supply shall be 115 VAC, 60 Hz.

M. Flow tubes shall be 150-lb flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or 2-inch pipe mounted as shown in the Drawings and/or as specified.

N. Magnetic flow meter systems shall be as manufactured by Rosemount, ABB/Fischer & Porter, Endress + Hauser or equal.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to Section 17700, Part 3, for further requirements.

- END OF SECTION -

SECTION 17740

ULTRASONIC LIQUID LEVEL MEASUREMENT SYSTEMS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the ultrasonic liquid level measurement systems, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17700 – Powered Instruments, General

### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one hand-held programmer under this Contract to calibrate and configure the level controllers specified herein. The programmer shall be furnished complete with battery plus one spare battery, carrying case and accessories. Programmer shall be furnished by the level instrument manufacturer, and shall be fully matched to the instrument furnished.

## PART 2 -- PRODUCTS

### 2.01 ULTRASONIC LEVEL CONTROLLERS

A. Each ultrasonic level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the level of process liquids or solids as shown on the Drawings and/or as specified herein. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the tank flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of 316 stainless steel material. Sensor mounting thread shall be 1" NPT.

C. The level sensor shall be unaffected by moisture droplets on the transducer face and operate on the ultrasonic echo ranging principle. The sensor shall also be fully submersible and resistant to corrosive materials. Sensor accuracy shall be a minimum of 0.25 percent of level measurement range, and include integral temperature compensation with an accuracy of 0.09% of range. Resolution shall be at least 0.1 percent of full range or 0.08 inches, whichever is greater.

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D. The transmitter shall be programmable by using a hand-held programmer. Display shall be LCD with backlighting, shall have the capability to display a minimum of 4 characters at one time, and shall be shielded from direct sunlight. The units shall have as a minimum, the required number of programmable set points to perform the functions specified. Each set point shall operate a set of contacts rated at 5 amps, 250 VAC, non-inductive.

E. The transmitter shall compensate for changes in temperature and air density. The controller shall be capable of performing the following functions: level monitor, both linear and nonlinear level to flow relationships, volumetric, open channel flow monitoring, differential control, and control of up to 6 pumps, alarms, monitor pump runtime and pump sequencing. Output level signal shall be linear, isolated 4-20 mA DC. Power requirement for the transmitter shall be 120 VAC, 60 Hz. The units shall have a NEMA 4X stainless steel or nonmetallic enclosure.

F. Ultrasonic level measurement system shall be manufactured by Endress + Hauser.

2.02 ULTRASONIC BED EXPANSION LEVEL MONITOR

A. Each bed expansion level monitoring system shall include one ultrasonic level sensor and an "intelligent" transmitter (controller). The ultrasonic level monitoring system shall be required to monitor the water/filter media interface as shown on the Drawings and/or as specified herein. Location of the sensor and transmitters shall be as shown on the Drawings and/or as specified.

B. For outdoor installation, the use of approved watertight conduit hub/glands shall be required. Tank mounting applications shall include mounting flange adapter supplied by the manufacturer, which is compatible with the process media and the tank flange connection. Channel or wall mounting applications shall include mounting bracket supplied by the manufacturer and constructed of 316 stainless steel material. Sensor mounting thread shall be 1" NPT.

C. The level sensor shall be rated IP68 for continuous submergence and operate on the ultrasonic echo ranging principle. The sensor shall also be resistant to corrosive materials. Sensor accuracy shall be a minimum of 0.25 percent of level measurement range. Resolution shall be 0.003 meters.

D. The transmitter shall be programmable by using a keypad display. Display shall be LCD with backlighting, and shall be shielded from direct sunlight. The units shall have as a minimum, the required number of programmable set points to perform the functions specified. Four programmable 10-amp, 250 VAC contacts shall be provided for alarming.

E. Output level signal shall be linear, isolated 4-20 mA DC. Power requirement for the transmitter shall be 120 VAC, 60 Hz. The units shall have a NEMA 4X stainless steel or nonmetallic enclosure.

F. The monitor shall include RS232, RS485 MODBUS RTU communications

G. Ultrasonic level measurement system shall be Echo Smart as manufactured by Entech Design or equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Where two or more ultrasonic level instruments are mounted in close proximity to each other, the transmitters shall coordinate operation to prevent interference from adjacent units. Coordination shall be accomplished via an interconnecting communication cable furnished by the manufacturer.

B. Where level transducers may become submerged, provide a manufacturer-supplied submergence hood.

C. Where ultrasonic level systems are used on solids measurement applications, provide a swiveling aiming device to allow easy adjustment of beam direction.

D. For open channel flow applications where the transducer is subject to direct sunlight, use an externally mounted temperature compensator mounted out of direct sunlight.

E. Refer to Section 17700, Part 3 of the specifications for additional requirements.

- END OF SECTION -

SECTION 17749

SUBMERSIBLE LEVEL (PRESSURE) SENSORS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the submersible level (pressure) sensors, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17700 - Powered Instruments, General

## PART 2 -- PRODUCTS

### 2.01 SUBMERSIBLE LEVEL (PRESSURE) SENSORS

A. Submersible level (pressure) sensors shall consist of a pressure-sensing probe assembly with a depth cable molded directly to the probe body. Sensing probe housing shall be fabricated of titanium or 316 stainless steel. The depth support cable shall be polyurethane and shall contain a Kevlar strength member, a vent tube, and conductors for electrical power and signal.

B. The sensor shall contain an encapsulated pressure sensing element which is electrically and physically isolated from the media via a ceramic or titanium isolation diaphragm. The pressure sensing connection shall be protected from damage by a removable acetal nose cone or equivalent guard.

C. Each submersible level transducer shall be provided with a NEMA 4X termination/junction box and aneroid bellows to prevent moisture from entering the vent tube.

D. Sensor specifications shall be as follows:

| | | |
|---|---|---|
| 1. | Sensor Rating: | NEMA 6 (IP68), loop-powered |
| 2. | Output Signal: | 4-20 mA, 2-wire design |
| 3. | Accuracy: | ± 0.25%, F.S. (full scale) |
| 4. | Long Term Stability: | ± 0.1% F.S./year |
| 5. | Zero Offset and Span Setting: | ± 0.25% F.S., max. |
| 6. | Operating Temperature: | -20 to +60 degrees C |
| 7. | Compensated Temperature: | -2 to +30 degrees C |
| 8. | Overpressure Limits: | At least 2x full scale range |
| 9. | Cable Length: | As required |

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E. Submersible level (pressure) sensors shall be manufactured by Dynotek, or approved equal.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17770

TEMPERATURE INDICATING TRANSMITTERS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the temperature indicating transmitters, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17700 - Powered Instruments, General

### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Furnish one Transmation Model 1074 RTD Calibrator with all accessories.

## PART 2 -- PRODUCTS

### 2.01 TEMPERATURE INDICATING TRANSMITTERS

A. Temperature indicating-transmitters shall be microprocessor-based with "smart" electronics, capable of accepting direct inputs from 2-, 3-, or 4-wire, platinum, copper, or nickel resistance temperature detectors (RTD) from 10 to 1000 ohms, thermocouple inputs, direct millivolt sources, and resistance/potentiometer devices. The indicating-transmitter shall be a true 2-wire device capable of operating on voltages up to 45 VDC.

B. The accuracy of the transmitter's Digital-to-Analog converter shall be within 0.02 percent of span. An LCD digital display shall be provided, capable of displaying mA, degrees in any units, ohms, or mV. Digital accuracy (Pt 100 RTD) shall be 0.10 degrees C. The indicator-transmitter shall contain an analog-to-digital converter which shall convert the RTD input to a digital signal and send it to the transmitter's electronics for further processing. Factory set correction coefficients shall be stored in the sensor's non-volatile memory for correction and linearization of the sensor output in the electronics section. The electronics section shall correct the digital signal from the sensor and convert it into a 4-20 mA analog signal for transmission to receiving devices. The electronics section shall contain configuration parameters and diagnostic data in non-volatile EEPROM memory and shall be capable of communicating, via a digital signal superimposed on the 4-20 mA output signal, with a remote interface device. Output signal damping shall be provided, with an adjustable time constant of 0-36 seconds. Long term stability (frequency of calibration) shall be not less than 0.25% of reading or 0.25 degrees C for five years.

C. The transmitter assembly shall be furnished with all necessary hardware for proper mounting as recommended by the manufacturer. Indicating-transmitter shall be housed in a watertight

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enclosure meeting NEMA 4X requirements. Enclosure shall be suitable for wall or 2-inch pipe stand mounting.

D. The transmitter shall provide a linear isolated 4-20 mADC output proportional to temperature.

E. The transmitter shall constantly monitor all aspects of the input circuitry and diagnose any system failures. If self-diagnostics detect a sensor burnout or transmitter failure, the analog output signal shall be driven either upscale or downscale to alert the user. Upscale and downscale burnout features shall be user-selectable.

F. Temperature measurement system shall be Model 3144P as manufactured by Rosemount Engineering Co., or equal.

## PART 3 -- EXECUTION

### 3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17772

RESISTANCE TEMPERATURE DETECTORS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the resistance temperature detectors, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Control and Information System Scope and General Requirements

B. Section 17700 - Powered Instruments, General

PART 2 -- PRODUCTS

2.01 RESISTANCE TEMPERATURE DETECTORS

A. Resistance Temperature Detectors (RTDs) shall meet the following minimum operational and performance requirements:

1. 4-wire, platinum, 100 ohm at 0°C, element RTD

2. Temperature Range: -100°C to 200°C

3. Repeatability: ±13°C; self heating, temperature measurement error: 1°C for water flowing at 3 ft/sec

4. Insulation Resistance 100 Mohms

5. RTD sheath shall be 316 stainless steel.

6. Thermowell shall be 316 stainless steel or as required to be compatible with and resistant to corrosion by the process fluid.

7. Probe assembly shall be spring loaded design.

8. The RTD and thermowell assembly shall be furnished with all necessary hardware for proper mounting as recommended by the manufacturer.

9. RTD connection head shall meet NEMA 4X requirements except where specified otherwise. Connection head and thermowell assembly shall include a union and two pipe nipples, one threading into the head and one into the thermowell for easy removal of the head and element from the thermowell.

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10. RTD connection head for the RTD assembly installed in designated explosive hazard areas shall be NEMA 7 explosion-proof head suitable for Class 1, Division 1, Group C & D.

B. RTD's shall be as manufactured by Rosemount Engineering Co., or equal.

2.02 THERMOWELLS

A. Thermowell shall meet the following minimum operational and performance requirements:

1. Thermowell shall be coordinated with RTD for proper fit and operation.

2. Thermowell shall be 316 stainless steel or as required to be compatible with and resistant to corrosion by the process fluid.

3. Thermowell shall be heavy duty threaded type with tapered shank and 1" NPT process connection.

B. Thermowells shall be as manufactured by Rosemount Engineering Co., or equal.

2.03 RTD WIRES

A. RTD extension wires shall be provided when the RTD assembly and the temperature indicating transmitter are mounted separately. RTD extension wires shall meet the following requirements:

1. Gauge size and type: 24 gauge, twisted, stranded silver, nickel or tinned copper.

2. Insulation: Teflon insulation for the conductor and outer jacket.

3. Conductor shall be 4-wire color coded.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17700, Part 3 of the Specifications.

- END OF SECTION -

SECTION 17800

ANALYTICAL INSTRUMENTS, GENERAL

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The instrumentation subcontractor shall furnish, install, test and place in operation the analytical instruments as scheduled in the following sections together with all signal converters, transmitters, isolators, amplifiers, etc. to interface with the process control system as shown on the Drawings and as specified. The Contractor may elect to install sensors on process lines provided that the instrumentation subcontractor provides full on-site supervision during installation. Mounting of associated indicators, sensors, sampling pumps, power supplies, brackets and appurtenances shall be provided as specified herein and shown on the Drawings.

B. It is the intent of the Contract Documents that all process taps, isolation valves, nipples, penetrations, embedded instrumentation supports, conduit, wiring, terminations, and the installation of process instrumentation on process lines shall be provided under this Contract. The instrumentation subcontractor shall supervise installation of equipment provided under this Section where installation is provided by others.

C. Tapping and connections for primary process sensors shall be sized to suit each individual installation and the requirements of the analytical instrument served. The Contractor shall ensure that the location, supports, orientation and dimensions of the connections and tapping for instruments furnished under this Section are such as to provide the proper bracing, the required accuracy of measurement, protection of the sensor from accidental damage and accessibility for maintenance while the plant is in operation. Isolation valves shall be provided at all process taps.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17500 – Enclosures, General

C. Section 17600 – Unpowered Instruments General

D. Section 17698 – Instrumentation and Control System Accessories

E. Section 17700 – Powered Instruments General

F. Analytical instruments furnished with mechanical equipment shall be furnished, installed, tested and calibrated as specified elsewhere in the Contract Documents.

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1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. Tools, supplies and spare parts shall be provided as specified in Section 17050.

B. Additional items as recommended by the analytical instrument manufacturers or as described for the specified analytical instrument sections shall be provided.

## PART 2 -- PRODUCTS

### 2.01 GENERAL

A. All instrumentation supplied shall be the manufacturer's latest design by Rosemount. Unless otherwise specified, instruments shall be solid state, electronic, using enclosures to suit specified environmental conditions. Microprocessor-based equipment shall be supplied unless otherwise specified. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings, or as required.

B. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Drawings, to comply with the National Electrical Code.

C. All field instrumentation for outdoor service shall be provided with enclosures that are suitable for outdoor service, as follows:

1. Where the manufacturer's enclosures are suitable for outdoor service, they shall be provided with instrument sunshades. Sunshades shall be Style E as manufactured by O'Brien Corporation, or equal. Where possible, these instruments shall be mounted in a north facing direction.

2. Where the manufacturer's standard enclosures are not suitable for outdoor service, instruments shall be mounted in Field Panels in accordance with Section 17520, Field Panels, or may be furnished with Vipak instrument field enclosures as manufactured by O'Brien Corporation, equivalent by Intertec, or equal. It shall not be necessary to provide the manufacturer's NEMA 4 or 4X enclosures for instruments that will be subsequently mounted in separate field panels.

D. All instruments shall return to accurate measurement without manual resetting upon restoration of power after a power failure.

E. Unless otherwise shown or specified, local indicators shall be provided for all instruments. Where instruments are located in inaccessible locations, local indicators shall be provided and shall be mounted as specified in Subsection 3.01 B herein. All indicator readouts shall be linear in process units. Readouts of 0-100% shall not be acceptable (except for speed and valve position). Isolated outputs shall be provided for all transmitters.

F. Unless otherwise specified, field instrument and power supply enclosures shall be 316 stainless steel, fiberglass (or equivalent) or PVC coated copper-free cast aluminum NEMA 4X construction.

G. Where separate elements and transmitters are required, they shall be fully matched, and unless otherwise noted, installed adjacent to the sensor. Special cables or equipment shall be supplied by the associated equipment manufacturer.

H. Electronic equipment shall utilize printed circuitry and shall be coated (tropicalized) to prevent contamination by dust, moisture and fungus. Solid-state components shall be conservatively rated for long-term performance and dependability over ambient atmosphere

fluctuations. Ambient conditions shall be -20 to 50 degrees C and 20 to 100 percent relative humidity, unless otherwise specified. Field mounted equipment and system components shall be designed for installation in dusty, humid, and corrosive service conditions.

I. All devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production. All equipment provided, where applicable, shall be of modular construction and shall be capable of field expansion.

J. All non-loop-powered instruments and equipment shall be designed to operate on a 60 Hz AC power source at a nominal 117 V, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

K. All analog transmitter and controller outputs shall be isolated, 4-20 milliamps into a load of 0-750 ohms, unless specifically noted otherwise. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless specified otherwise.

L. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.

2.02 ANALYSIS INSTRUMENTS

A. Liquid samples shall not pass through housings containing analyzer electronics. Process fluid temperature will be within a range of 40 to 90 degrees F.

B. Where ambient temperatures will affect accuracy by more than 1 percent of span, a suitable isothermal enclosure with thermostatically controlled space heater shall be provided.

C. Sample assemblies shall be suitable for submersion or flow-through service as noted and shall be chemically inert to constituents of raw wastewater solids or other chemical environment, as scheduled. Where the sample is drawn prior to filtration, the sample assemblies shall be capable of handling solids and grease.

D. Each analyzer requiring reagents and/or other replaceable parts shall be furnished with sufficient chemicals and replaceable parts for startup and acceptance tests and the specified warranty period.

E. Contractor's submittals on these analyzers shall include information on monthly reagent consumption and a list of replaceable parts required for periodic maintenance and the recommended operating periods between replacements. Installation of analyzers and sample preparation shall be in accordance with the analyzer manufacturer's instructions.

F. Analysis instrumentation performance, accuracy and reproducibility shall be as prescribed in APHA/AWWA/WEF "Standard Methods for the Examination of Water and Wastewater", latest edition. For those measurements specified herein, for which performance characteristics are not listed in the above, the supplier shall state instrument performance characteristics. The "referee" method shall be as prescribed in EPA Methods for Chemical Analysis of Water and Wastes (1971).

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Equipment shall be located so that it is accessible for operation and maintenance. The instrumentation subcontractor shall examine the Drawings and shop drawings for various items of equipment in order to determine the best arrangement for the work as a whole, and shall supervise the installation of process instrumentation supplied under this Division.

2. Electrical work shall be performed in compliance with all applicable local codes and practices. Where these specifications and the Drawings do not delineate precise installation procedures, API RP550 shall be used as a guide to installation procedures.

B. Equipment Mounting and Support

1. Field equipment shall be wall mounted or mounted on two-inch diameter pipe stands welded to a 10-inch square by 1/2-inch thick base plate unless shown adjacent to a wall or otherwise noted. Materials of construction shall be aluminum or 316 stainless steel. Instruments attached directly to concrete shall be spaced out from the mounting surface not less than 1/2-inch by use of phenolic spacers. Expansion anchors in walls shall be used for securing equipment or wall supports to concrete surfaces. Unless otherwise noted, field instruments shall be mounted between 48 and 60 inches above the floor or work platform.

2. Embedded pipe supports and sleeves shall be Schedule 40, Type 316 stainless steel pipe, ASA B-36.19, with stainless steel blind flange for equipment mounting as shown on the Drawings.

3. Materials for miscellaneous mounting brackets and supports shall be 316 stainless steel construction.

4. Pipe stands, miscellaneous mounting brackets and supports shall comply with the requirements of Division 5 of the specifications.

5. Transmitters shall be oriented such that output indicators are readily visible.

C. Control and Signal Wiring

1. Electrical, control and signal wiring connections to transmitters and elements mounted on process piping or equipment shall be made through liquid-tight flexible conduit. Conduit seals shall be provided where conduits enter all field instrument enclosures and all cabinetry housing electrical or electronic equipment.

3.02 ADJUSTMENT AND CLEANING

A. The instrumentation subcontractor shall comply with the requirements of Division 1 of these Specifications and all instrumentation and control system tests, inspection, and calibration

requirements for all instrumentation and controls provided under this Contract and specified herein. The Owner, or his designated representative(s), reserves the right to witness any test, inspection, calibration or start-up activity. Acceptance by the Engineer of any plan, report or documentation relating to any testing or commissioning activity specified herein shall not relieve the Contractor of his responsibility for meeting all specified requirements.

B. The instrumentation subcontractor shall provide the services of factory trained technicians, tools and equipment to field calibrate, test, inspect and adjust each instrument to its specified performance requirement in accordance with manufacturer's specifications and instructions. Any instrument which fails to meet any Contract requirements, or any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer, at no cost to the Owner. The Contractor shall bear all costs and provide all personnel, equipment and materials necessary to implement all installation tests and inspection activities for equipment specified herein.

C. At least 60 days before the anticipated initiation of installation testing, the Contractor shall submit to the Engineer a detailed description, in duplicate, of the installation tests to be conducted to demonstrate the correct operation of the instrumentation supplied hereunder.

D. Field instrument calibration shall conform to the following requirements:

1. The instrumentation subcontractor shall provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument supplied under this Contract to its specified accuracy in accordance with the manufacturer's specification and instructions for calibration.

2. Each instrument shall be calibrated at 0, 25, 50, 75 and 100 percent of span using test instruments and specified chemicals of known values to simulate inputs and read outputs. Test instruments shall be rated to an accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Where applicable, such test instruments shall have accuracy's as set forth by the National Institute for Standards and Technology (NIST).

3. The instrumentation subcontractor shall provide a written calibration sheet to the Engineer for each instrument, certifying that it has been calibrated to its published specified accuracy. The Contractor shall submit proposed calibration sheets for various types of instruments for Engineer approval prior to the start of calibration. This sheet shall include but not be limited to date, instrument tag numbers, calibration data for the various procedures described herein, name of person performing the calibration, a listing of the published specified accuracy, permissible tolerance at each point of calibration, calibration reading as finally adjusted within tolerance, defect noted, corrective action required and corrections made.

4. If doubt exists as to the correct method for calibrating or checking the calibration of an instrument, the manufacturer's printed recommendations shall be used as an acceptable standard, subject to the approval of the Engineer.

5. Upon completion of calibration, devices calibrated hereunder shall not be subjected to sudden movements, accelerations, or shocks, and shall be installed in permanent protected positions not subject to moisture, dirt, and excessive temperature variations. Caution shall be exercised to prevent such devices from being subjected

to overvoltages, incorrect voltages, overpressure or incorrect air. Damaged equipment shall be replaced and recalibrated at no cost to the Owner.

6. After completion of instrumentation installation, the instrumentation subcontractor shall perform a loop check. The Contractor shall submit final loop test results with all instruments listed in the loop. Loop test results shall be signed by all representatives involved for each loop test.

- END OF SECTION -

SECTION 17801

pH ANALYZERS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Subcontractor shall furnish, test, install and place in satisfactory operation the pH analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 - Information and Control System Scope and General Requirements

B. Section 17800 - Analytical Instruments, General

## PART 2 -- PRODUCTS

### 2.01 pH SENSORS

A. pH sensors shall be encapsulated in liquid crystal polymer thermoplastic and utilize the differential electrode measurement technique. The sensors shall include an integral preamplifier capable of sending a signal over a 5 conductor shielded cable. The sensors shall have the following features and minimum performance requirements:

1. Glass process electrode in buffered pH 7 solution
2. Integral preamplifier
3. Integral temperature compensation sensor
4. Measuring range: 0-14 pH
5. Maximum pressure: 100 psig at 70°C
6. Sensitivity: ±0.01 pH
7. Stability: 0.03 pH per 24 hours, non-cumulative
8. Operating temperature: 0°C to 70°C
9. Material: Ryton material, or equally resistive and durable material
10. Sensor cable length: minimum of 10 feet or as shown on the Drawings
11. Built-in Pt 1000-ohm RTD temperature element.

B. Sensors shall be submersion mounted and provided with a PVC mounting pipe and a PVC electrode protector, or as shown on the Drawings.

C. Sensors shall be pHD sc Digital Differential pH sensors by Hach.

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### 2.02 pH TRANSMITTERS

A. pH transmitters shall be microprocessor-based with a non-volatile memory for calibration data. Transmitters shall be capable of accepting a signal from the sensors specified herein

and shall provide a linear, isolated 4-20 mA DC proportional output signal for pH and for temperature. The transmitters shall have the following features and minimum performance requirements:

1. NEMA 4X enclosure suitable for outdoor service
2. Nominal input power: 120 VAC, 60 Hz
3. Ambient conditions: -4°F to 140°F, 0-95% relative humidity, with less than 7W sensor load
   -4°F to 104°F, 0-95% relative humidity, with less than 25W sensor load
4. Graphic dot matrix LCD, 128 x 64 pixels with LED backlighting
5. Panel face configuration keypad
6. Temperature compensation
7. Control functions: PID, high/low phasing, setpoint, deadband, overfeed timer, off delay, and on delay
8. Alarms: dual high/low alarms, on/off delays
9. Self diagnostics
10. Automatic calibration with buffer recognition
11. Three relay outputs

B. Controller shall be by the same manufacturer as the sensor.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800, Part 3.

- END OF SECTION -

SECTION 17821

TURBIDITY MONITORING SYSTEMS (LOW RANGE)

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Subcontractor shall furnish, test, install and place in satisfactory operation the low range turbidity monitoring systems, with all spare parts, accessories, and appurtenances as specified herein and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17800 – Analytical Instruments, General

### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. One complete calibration kit shall be provided and shall include a 1-liter calibration cylinder, auto pipette and 1 pint bottle of 4000 NTU Formazin Standard Solution with instructions for use.

## PART 2 -- PRODUCTS

### 2.01 TURBIDITY MONITORS (LOW RANGE)

A. Turbidity sensors and controllers shall be microprocessor-based, meeting the International Standard for measurement of Turbidity (ISO 7027-1984 (E)) and shall provide continuous monitoring.

B. Features

| | | |
|---|---|---|
| 1. | Range: | 0-100 NTU |
| 2. | Accuracy: | ±2 percent from 0-40 NTU<br>±5 percent from 40-100 NTU |
| 3. | Resolution: | 0.001 NTU |
| 4. | Sample Flow: | 250-750 mL/min. |
| 5. | Sample Temperature Range: | 0-50°C |
| 6. | Outputs: | Selectable for 0-10mV, 0-100mV, 0-1V or 4-20 mA. |
| 7. | Diagnostics: | Self test diagnostics with alarm indication. |
| 8. | Alarms: | Set point alarms for instrument warning and system fail.<br>Two 5A, 230 VAC SPDT alarm relays. |
| 9. | Power Requirements: | 115/230 VAC, 50/60 Hz, switch selectable. |
| 10. | Enclosure: | Sensor and controller enclosures shall be rated NEMA 4X. |
| 11. | Manufacturer: | Hach Model 1720E, Sigma or approved equal. |

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PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800, Part 3 of the specifications.

- END OF SECTION -

SECTION 17831

CHLORINE ANALYZERS

## PART 1 -- GENERAL

### 1.01 THE REQUIREMENT

A. The Subcontractor shall furnish, test, install and place in satisfactory operation the chlorine residual analyzers, with all spare parts, accessories, and appurtenances as herein specified and as shown on the Drawings.

### 1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17000 – Control and Information System Scope and General Requirements

B. Section 17800 – Analytical Instruments, General

### 1.03 TOOLS, SUPPLIES AND SPARE PARTS

A. One free chlorine sensor and one free chlorine membrane replacement kit per analyzer.

B. One sample conditioning kit and one acidification/cleaning kit.

## PART 2 -- PRODUCTS

### 2.01 CHLORINE ANALYZER

A. The amperometric chlorine analyzers shall be in accordance with EPA Method 334.0 and can be used for reporting chorine residual measurements.

B. Features

| | | |
|---|---|---|
| 1. | Range: | 0-10 ppm free or total residual chlorine |
| 2. | Free Chlorine Accuracy: | +/- 3% of reference test at constant pH less than 7.2 |
| 3. | Repeatability: | 30 ppb or 3% whichever is greater |
| 4. | Resolution: | 0.001 pm |
| 5. | Sample Flow: | 30 to 50 L/Hr, optimal is 40 L/hr |
| 6. | Sample Inlet Pressure: | 0.5 bar Maximum |
| 7. | Sample Temperature Range: | 5-45°C |
| 8. | Sample Time: | continuous |

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| | | |
|---|---|---|
| 9. | Outputs: | From the sc200 controller, two selectable for 0-10mV, 0-100mV, 0-1V or 4-20 mA. When required, an additional 4-20 mA expansion module shall be provided. The expansion module shall have three (3) additional isolated 4-20 mA outputs available.<br>4-20 mA analog shall be isolated. Output span shall be fully programmable |
| 10. | Diagnostics: | Self test diagnostics with alarm indication. |
| 11. | Alarms: | Two set point alarms, instrument warning alarm, and system shutdown alarm. Alarm shall be SPDT dry contact relay output rated at 5A, 230 VAC SPDT alarm relays. |
| 12. | Power Requirements: | 115/230 VAC, 50/60 Hz, switch selectable. |
| 13. | Enclosures: | Sensors and controller enclosures shall be mounted on a back plane with the controller rated NEMA 4X for wall mounting. |

C. Residual chlorine analyzer shall be HACH Model CLF10 sc, or CLT10 sc.

PART 3 -- EXECUTION

3.01 REQUIREMENTS

A. Refer to Section 17800, Part 3 of the specifications.

- END OF SECTION -

SECTION 17910

INSTRUMENT SCHEDULE

## PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation all instrumentation as herein specified and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 17900 - Schedules and Control Descriptions

B. Section 17950 - Functional Control Descriptions

## PART 2 -- INSTRUMENT SCHEDULE

| **Venturi Flow Tubes – Section 17611** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| FE - | Filter 1 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 2 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 3 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 4 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 5 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 6 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 7 Effluent Rate | 0 – 3.6 MGD | 10” |
| FE - | Filter 8 Effluent Rate | 0 – 3.6 MGD | 10” |

| **Level Switch – Section 17670** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| LSH - | Backwash Well High Level | | Interlock High Service Fill Valve. |
| LSL - | Backwash Water Pump No. 1 Low Level | | Interlock BW Pump No. 1. |
| LSL - | Backwash Water Pump No. 2 Low Level | | Interlock BW Pump No. 2. |
| LSHH - | Backwash Well High High Level | | |

| **Pressure Switch – Section 17675** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| PSH - | Backwash Water Pump No. 1 High Discharge Pressure Switch | | |
| PSH - | Backwash Water Pump No. 2 High Discharge Pressure Switch | | |

| **Magnetic Flow Meters – Section 17701** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| FE/FIT- | Backwash Pump Discharge Flow | 0 – 10 MGD | 20” |
| FE/FIT- | FinishedWater Flow | 0 – 25 MGD | 36” |

| **Temperature Indicating Transmitters – Section 17770** | | | |
|---|---|---|---|
| **Tag Number** | **Service Description** | **State/Span** | **Remarks** |
| TIT- | Filtered Water Control Structure | | |

| **Ultrasonic Level Measurement Systems – Section 17740** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| LIT- | Filter No. 1 Level | | |
| LIT- | Filter No. 2 Level | | |
| LIT- | Filter No. 3 Level | | |
| LIT- | Filter No. 4 Level | | |
| LIT- | Filter No. 5 Level | | |
| LIT- | Filter No. 6 Level | | |
| LIT- | Filter No. 7 Level | | |
| LIT- | Filter No. 8 Level | | |
| LIT- | Filter No. 1 Bed Expansion | | |
| LIT- | Filter No. 2 Bed Expansion | | |

| **Submersible Level (Pressure) Sensors – Section 17749** | | | |
|---|---|---|---|
| Tag Number | Service Description | State/Span | Remarks |
| LIT- | Backwash Tank Level | | |

| **Pressure Indicating Transmitters - Section 17760** | | | |
|---|---|---|---|
| **Tag Number** | **Service Description** | | |
| PDIT- | Filter 1 Loss of Head | 0-10 feet | |
| PDIT- | Filter 2 Loss of Head | 0-10 feet | |
| PDIT- | Filter 3 Loss of Head | 0-10 feet | |
| PDIT- | Filter 4 Loss of Head | 0-10 feet | |
| PDIT- | Filter 5 Loss of Head | 0-10 feet | |
| PDIT- | Filter 6 Loss of Head | 0-10 feet | |
| PDIT- | Filter 7 Loss of Head | 0-10 feet | |
| PDIT- | Filter 8 Loss of Head | 0-10 feet | |
| FIT- | Filter 1 Effluent Rate | | Coordinate with Venturi Manufacturer |
| FIT- | Filter 2 Effluent Rate | | Coordinate with Venturi Manufacturer |
| FIT- | Filter 3 Effluent Rate | | Coordinate with Venturi Manufacturer |
| FIT- | Filter 4 Effluent Rate | | Coordinate with Venturi |

| | | | |
|---|---|---|---|
| | | | Manufacturer |
| FIT- | Filter 5 Effluent Rate | | Coordinate with Venturi Manufacturer |
| FIT- | Filter 6 Effluent Rate | | Coordinate with Venturi Manufacturer |

| | | | |
|---|---|---|---|
| FIT- | Filter 7 Effluent Rate | | Coordinate with Venturi Manufacturer |
| FIT- | Filter 8 Effluent Rate | | Coordinate with Venturi Manufacturer |

| **pH Meter - Section 17801** | | | |
|---|---|---|---|
| **Service Description** | | **State/Span** | **Remarks** |
| AIT- | CT Basin (Cell 4 / Cell 8) | 0-14 | |
| TIT- | CT Basin (Cell 4 / Cell 8) | 30-80 deg. F | Combined in pH sensor. |

| **Turbidity Analyzers (Low Range) - Section 17821** | | | |
|---|---|---|---|
| **Tag Number** | **Service Description** | **State/Span** | **Remarks** |
| AIT- | Combined Filters Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 1 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 2 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 3 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 4 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 5 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 6 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 7 Effluent Turbidity | 0-10 NTU | |
| AIT- | Filter 8 Effluent Turbidity | 0-10 NTU | |

| **Chlorine Analyzers – Section 17831** | | | |
|---|---|---|---|
| **Tag Number** | **Service Description** | **State/Span** | **Remarks** |
| AIT- | Filter Water Control Structure | Free Chlorine | |
| AIT- | CT Basin (Cell 4 / Cell 8) | Free Chlorine | |

- END OF SECTION -

SECTION 17950

FUNCTIONAL CONTROL DESCRIPTIONS

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Subcontractor shall furnish, test, install and place in satisfactory operation all equipment as herein specified and as shown on the Drawings. The Subcontractor shall be responsible for furnishing complete functioning systems as described herein.

B. Together with the control system input/output schedule, the equipment specifications (including functional descriptions for local equipment control panels), and the Drawings, the functional control descriptions describe the required operation, monitoring, and control of the facilities included in this Contract.

C. THE FUNCTIONAL DESCRIPTIONS CONTAIN REQUIREMENTS FOR FURNISHING AND INSTALLING LABOR AND MATERIALS THAT MAY NOT APPEAR ELSEWHERE IN THE CONTRACT DOCUMENTS.

D. All equipment and services required in equipment local control panels provided to implement the monitoring and control functions described herein or in the process input/output schedules shall be provided by the Subcontractor through individual equipment suppliers.

E. Unless specifically stated otherwise, all interconnected wiring between all instruments, panels, controls, and other devices listed in the functional descriptions as required to provide all functions specified herein shall be furnished by the electrical subcontractor under Division 16. The electrical subcontractor shall provide all cable and conduit required to carry all signals listed in the process input/output schedules. Special cables that are required for interconnection between sensors or probes and transmitters or signal conditioners shall be furnished with the instrumentation devices by the equipment supplier.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01520 – Maintenance of Utility Operations During Construction

B. Section 17900 – Schedules and Control Descriptions, General

C. Section 17910 – Instrument Schedule

D. Section 17920 – Control System Input/Output Schedule

PART 2 -- FUNCTIONAL CONTROL DESCRIPTIONS, GENERAL

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2.01 DEFINITIONS

A. RUNNING status signals shall be from auxiliary contacts provided with the motor control equipment (i.e., starter, VFD, SCR, etc.).

B. AUTO status signals shall be defined as HAND-OFF-AUTO, HAND-OFF-REMOTE, OPEN-CLOSE-REMOTE, OPEN-CLOSE-AUTO, etc. switches in the proper position to provide for total automatic control by the process control system.

C. FAIL status signals shall be defined as motor overload and/or any other shut down mode such as overtorque, overtemperature, low oil pressure, high vibration, etc.

D. READY status signal shall be defined as all conditions, including equipment control power, satisfied to permit remote control of the equipment.

2.02 CONVENTIONS

A. Operator workstation graphic display symbols and indicator lights on all MCC's, control panels, starter enclosures, etc. shall conform to the following color convention:

| Condition | Color |
|---|---|
| Running/On/Open | Green |
| Auto/Ready | White |
| Stopped/Off/Closed | Red |
| Fail/Alarm | Amber |
| Generic Status | Blue or White |

2.03 PROCESS CONTROL

A. Where setpoints, operating limits, and other control settings are provided by the functional descriptions, these settings shall be initial settings only and shall be used for assistance in the initial startup of the plant. All such settings shall be fully adjustable and, based on actual operating conditions, the instrumentation subcontractor shall make all necessary adjustments to provide smooth, stable operation at no additional cost to the Owner.

B. Provision shall be made in PLC logic to suppress nuisance alarms and control actions by the following means:

1. For alarms and control actions derived from analog input signals, use adjustable time delays and deadbands.

2. For alarms and control actions derived from discrete input signals, use adjustable time delays.

3. Initial settings for time delays shall be 10 seconds (range 0-120 seconds). Initial settings for deadbands shall be 5% of span (range 0-100%).

4. Equipment that is started or stopped manually by the operator shall start or stop immediately, with no time delay.

C. All setpoint control shall be by PID control algorithms. Where only proportional control is specified, tuning constants shall be used to reduce the Integral and Derivative functions to zero. All setpoints, sequence times, sequence orders, dead bands, PID tuning parameters, PLC delay timers, variable speed operating range limits, and similar control constants shall be accessible and alterable from the operator workstations.

D. Unless otherwise specified, all equipment shall automatically restart after a power failure utilizing adjustable start delay timers in PLC control logic. Unless otherwise specified, all PLC control strategies shall be based upon automatic restart after a power failure and shall return to a normal control mode upon restoration of power.

E. The PLC shall be capable of receiving initial run-time values for existing and proposed equipment. Initial run-time shall not automatically be assumed to be zero.

F. Equipment failure shall be generated through the PLC for any drive, motor, etc. for which a command has been issued, but for which the PLC is not receiving a confirming status signal (e.g., start command with no run feedback). The failure shall be logged.

G. Instrument failure shall be generated via the operator work stations for any instrument which is generating a signal which is less than 4 mA or greater than 20 mA.

H. A control program that controls multiple pieces of equipment shall not be prevented from running because not all of the equipment is in AUTO. If equipment within an equipment chain is required to be running for program operation and it is running in HAND or MANUAL, then the program shall run and control the other equipment that is in AUTO.

I. All PLC wait states (internal time delays, etc.) after an operator action shall be displayed on the operator workstation.

## PART 3 -- FUNCTIONAL CONTROL DESCRIPTIONS

### 3.01 GENERAL

A. This section provides a narrative description of the operation and control features of the proposed facilities at the Richmond Road Station Water Treatment Plant (WTP). The processes covered in this narrative description include filtration, backwash facilities, chlorine contact basin and chemical feed vault.

B. Existing chemical storage and feed facilities will be provided for chlorination and ammonia. Chlorination upstream of the contact basin will use compound loop control to pace feed on flow and chlorine residual.

### 3.02 FILTRATION

A. Conventional dual media filters with sand and anthracite will be utilized for filtration. The filters and associated clearwell will be constructed on the south side of the existing plant site. Each filter unit will be equipped with a water level sensor and a flow control valve in the effluent piping. The filter control valve will maintain a constant flowrate through the filter. The control valve will gradually open as the headloss through the media increases, thereby achieving constant rate flow control. A short-form insert Venturi meter will be provided for filter effluent flow control. Air scour will be provided for backwashing.

B. The filtration system will include the following:

1. Open/close valves provided for each filter with limit switches for indicating position and Local-Off-Remote switches and Open-Stop-Close pushbuttons integral to the valve operator:

   - Filter influent valve (open during normal operation)
   - Filter effluent valve (open during normal operation)
   - Backwash isolation valve (closed during normal operation)
   - Backwash drain valve (closed during normal operation)
   - Filter to waste valve (closed during normal operation)
   - Air supply valve (closed during normal operation)

2. A filter rate-of-flow controller, insert Venturi flowmeter, differential pressure indicating transmitter, and a modulating effluent flow control valve provided for each filter. In addition, a master level control program and filter water level ultrasonic level indicating transmitter will be used to maintain desired total filter flowrate.

3. An ultrasonic level indicating transmitter for each filter.

4. A differential pressure transmitter provided for each filter to measure filter loss-of-head.

5. A filter effluent turbidity meter provided for each filter.

6. A combined filter effluent turbidity meter.

7. Two filter backwash pumps with flow monitoring and control.

8. Two air scour blowers with controls.

9. Depth of bed ultrasonic level transmitters for filter nos. 1 and 2.

C. Monitoring and control for the filters will be as follows:

1. When filter valves are in the Local control mode, the valve will be opened and closed with the Open-Stop-Close pushbuttons. When valves are the in Remote mode, valve control shall manually at the filter console or automatically via the plant control system. Valve position for all valves will be indicated at console with pilot lights for open/close valves and numeric indicator for modulating valves.

2. Individual filter level will be indicated for each filter at the operator workstations.

3. Normal Filtration

   a. During normal filtration, when the level of water in the filter is within the desired 6-inch range as determined by the master level control program, effluent flow control will be achieved as follows. The filter rate-of-flow controller will establish the desired effluent flowrate based on the plant flow

setpoint and the number of filters in service. The filter effluent flowmeter will transmit an analog signal proportional to flow to the filter rate-of-flow controller in the PLC program. The controller will transmit an analog signal to modulate the position of the effluent flow control valve to achieve the desired flowrate. A constant flowrate through each filter will be maintained during normal operation.

b.) During normal filtration, when the level of water in the filter is outside the desired 6-inch range, effluent flow control will be achieved as follows. The master level control program will direct the filter rate-of-flow controllers to restrict flow if the influent level is below the desired range limit and allow more flow if the influent channel level is above the desired range limit. When the water in the influent channel returns to the desired range, the filter rate-of-flow controllers will return to normal operation. Valve adjustments will occur gradually by limiting the rate-of change of the position command output.

c. The position of each effluent flow control valve (0-100% open), the flowrate through each filter, and the level of water in the filter will be monitored from the consoles.

d. During normal filter operation, the differential pressure transmitter provided at each filter will transmit an analog signal proportional to filter head loss to the control system. Loss of head for each filter will be indicated at the consoles. If filter loss of head reaches the high level alarm setpoint, filter backwash will be initiated by plant operators as described below.

e. During normal filter operation, the filter effluent turbidity analyzer provided for each filter will transmit an analog signal proportional to turbidity to the control system. Effluent turbidity will be displayed at the Operator Workstations. If turbidity reaches the high level setpoint, plant operations will be notified that a filter backwash should be initiated as described herein. If the turbidity reaches a high level alarm setpoint, the filter will be shut down.

4. Filter Backwash

a. Filter backwash will be initiated manually by the operator or automatically by the control system based on turbidity, loss of head, or elapsed time since last backwash. It will be possible to delete one or more of the parameters as a basis of control.

b. The control system will allow only one filter to be backwashed at a time. When a backwash is initiated, the control system will check the volume available in the back wash well to determine if the level is high enough for a backwash. The control system will also check the water level in the backwash holding tanks to determine whether adequate volume is available to receive the backwash volume.

c. When a backwash is initiated, the control system will calculate required total volume of water for the backwash from the low (up), high, and low (down) wash rates/durations input by the operator. If required volume is less than

available volume, filter backwash will proceed. If required volume is more than available volume, an alarm will be displayed at plant SCADA HMI.

d. The operator will interact with the control strategy by entering the following parameters at the SCADA HMI:

- Air scour duration
- Low wash rate/duration (up)
- High wash rate/duration
- Low wash rate/duration (down)
- Maximum elapsed time between backwashes
- Maximum loss of head
- Maximum turbidity

Once a backwash is initiated, the filter rate-of-flow controller will no longer respond to the setpoint flowrate or the master level control program. The filtration rate setting will track the setpoint for the operating filters to provide for a “bumpless” return to service.

e. Backwash Sequence

(1) The filter backwash sequence will begin with the closing of the filter influent valve. Closing the influent valve will also stop the clock for the filter run length. The filter fill continue to process water (filter effluent valve will remain in its previous position) until the level is drawn down to approximately 12 inches above the filter media as measured by the individual filter level monitoring system. An alarm will occur if the minimum level is not obtained within 15 minutes. At this point, the filter rate-of-flow controller setpoint will be reset by the control system to zero flow, which will close the rate control valve. The backwash drain valve will then open. The air blower will then start and the media will be air-scoured for a preset duration with no washwater flow.

(2) Remaining filters in service will adjust their effluent flow rate to maintain the plant production rate (i.e. raw water flow rate will not change).

(3) Filter backwash water will be provided from one of two redundant backwash supply pumps drawing suction from the backwash well. The operator will select the backwash pump. A magnetic flow meter will be used in conjunction with variable frequency-driven pumps to automatically adjust the washwater flowrate. After an adjustable time delay (air-only wash), the backwash supply pump will be started against a closed valve at the filter and a one percent open control valve at the pump to allow air to escape from the supply piping via an

air release valve. The backwash isolation valve will then slowly open, and the low wash cycle will start. A combined air-water wash will proceed while the filter level rises. When the filter water level reaches the bottom of the wash water troughs, the air wash valve will close, and the air blower will shut down.

(4) After an adjustable preset time duration for low water wash, the variable frequency drive (VFD) will increase speed further to provide high wash rate for an adjustable time duration. After the high water wash, the VFD will slow the pumps to deliver the low wash rate for an adjustable time duration. At the end of the second low wash cycle, the backwash isolation valve at the filter will close. The backwash supply pump will stop, and after an adjustable time delay, the backwash drain valve will close.

(5) At the end of the backwash cycle, the filter will automatically be returned to constant flowrate control, and the influent valve will slowly open. The filter box will fill to its normal level. Once the normal level is reached, the filter to waste cycle will be automatically initiated. (The filter effluent valve is still closed.)

(6) The filter to waste mode will continue until the preset turbidity level is reached and maintained for a preset time duration. If the preset turbidity level is not reached after an operator-adjustable duration, an alarm will be displayed at the plant SCADA HMI.

(7) At the end of the filter to waste cycle, the filter to waste valve will close simultaneously with the opening of the filter effluent valve. Once the filter effluent valve opens, the filter run clock will reset and begin recording filter run time. The control system will calculate and record the volume of washwater used and the amount of filter-to-waste flow sent to the backwash holding tank.

(8) When the filter is in the automatic backwash mode, any disruption in the cycle such as a valve failure or power failure will cause the control system to shut the filter down. The filter influent and all three effluent (filter control, filter effluent, and rewash) valves will be closed. The filter will remain offline until an operator diagnoses the problem and manually returns the filter to service.

(9) The following conditions will initiate a “Backwash Fail” alarm condition and will be reason for removing the filter from service:

-Neither blower starts

-Neither backwash pump starts

-No level signal is available

-Any valve fails to open or close, or fails to reach its position in the allotted time

-Backwash flow control system fails to control the flow within 10 percent of setpoint

-Power fails during backwash

3.03 CT BASIN, SAMPLING AND CONTROL

A. The chlorine contact basin will meet design requirements of the American Water Works Company Standards and provide 0.5-log inactivation of Giardia and a 2-log virus inactivation. The volume when full will be 0.275 MG. Disinfection using free chlorine will be provided at the combined filter effluent structure. To retard the formation of chlorination DBPs, conversion of the free chlorine residual to chloramines will be provided via the injection of ammonia downstream of the CT basin in the chemical injection manhole. The layout will allow the contact basin to operate in series or with half out of service (for limited duration) by the opening and closing of manual gates and valves. Post treatment chemicals, fluoride and sodium hypochlorite, will be fed prior to the filtered water line entering the finished water storage basin.

1. The contact basin will include the following:

   a. The basin will be provided with vents, overflows, and adequate access hatches.

   b. Level, temperature, chlorine residual and pH monitoring will be provided for each half of the basin.

2. Monitoring and control of CT Basin will be as follows:

   a. Contact basin temperature, chlorine residual, and pH will be indicated at the plant SCADA HMI.

B. The existing chemical storage and feed systems will be maintained during and after construction. Changes to the chemical injection point locations will be made as follows at the Richmond Road Water Treatment Plant

**TABLE 17.1**

| Chemical | Purpose | New Application Points |
|---|---|---|
| Chlorine | Disinfection | Combined Filter Effluent (Chemical Dosing Manhole) |
| Hydrofluosilicic Acid | Fluoridation | Chemical Dosing Manhole |
| Ammonia | Conversion of Free Chlorine Residual to Chloramines | Chemical Dosing Manhole |
| Phosphate | Corrosion Inhibitor | Chemical Dosing Manhole |

Note: Secondary application points are shown in parentheses.

A description of each proposed chemical storage and feed system as well as information on control of each system are included in the following sections.

C. Control Operations

1. The PLC shall monitor and display the following at the plant SCADA HMI:

   a. Flow at the chemical feed vault
   b. Free chlorine residual at the combined filter effluent weir
   c. Free chlorine residual at the chemical feed vault
   d. pH at the chemical feed vault
   e. Temperature at the combined filter effluent weir
   f. Temperature at the chemical feed vault

2. The control system shall calculate actual C*T, once an hour, on the hour, based on flow rate, contact basin volume, a baffle factor of 0.7, and disinfectant residual concentration. The disinfection strategy in operation and chemical application points shall be taken into account in these calculations. The control system shall also determine required C*T based on required log inactivation (0.5 for Giardia), temperature, pH, and residual concentration from published EPA information. If the actual C*T value is less than the required C*T value, an alarm message shall be generated.

- END OF SECTION -