KENVIRONS

CONTRACT DOCUMENTS & TECHNICAL SPECIFICATIONS

FOR THE

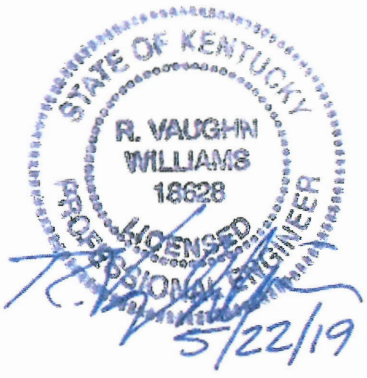
GREEN RIVER VALLEY WATER DISTRICT

CONTRACT 1 – WATER TREATMENT PLANT EXPANSION

VOLUME 2 OF 2

Prepared By:

KENVIRONS, INC.
770 WILKINSON BLVD.
FRANKFORT, KENTUCKY 40601



PROJECT NO. 2014042

MAY 2019

Kenvirons, Inc.

Civil & Environmental Engineering and Laboratory Services

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TECHNICAL SPECIFICATIONS

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SECTION 01001

SPECIAL CONDITIONS

1.0 DAMAGE TO EQUIPMENT STORED AND/OR IN PLACE PRIOR TO INITIAL OPERATION

A. Any equipment damaged or which has been subjected to possible damage by reason of inundation, improper storage and/or protection during the construction period of project, shall be corrected only as follows:

i. Be replaced with new equipment.

ii. With approval of the Engineer, be returned to the manufacturer of the equipment, or his authorized repair agency, for inspection and repair provided, however, that such repair after inspection will place the equipment in new condition, and restore the manufacturer's guarantee the same as for new equipment.

2.0 SALVAGED MATERIALS AND EQUIPMENT

A. All materials and/or equipment to be removed from existing structures and not specifically specified to be re-used shall remain the property of the Owner. Such materials and/or equipment shall be stored on sites by the Contractor as directed by the Engineer acting on the Owners behalf.

B. The use of second hand and/or salvaged materials will not be permitted, unless specifically provided for in the detailed specifications. Materials and equipment shall be new when turned over to the Owner.

3.0 TEMPORARY FACILITIES

A. Build and maintain temporary offices and storage sheds as necessary for the work. Location of temporary buildings shall be subject to the approval of the Engineer.

B. Provide temporary heat, light and power required for the work. Temporary telephone service shall be provided in the job office paid for by the General Contractor, except that the party placing a long distance call shall pay the toll charge.

C. Each Contractor shall construct and maintain, in a sanitary condition, sanitary facilities for his employees and also employees of his subcontractors. At completion of the contract work these sanitary facilities shall be properly disposed of as directed by the Engineer.

D. Temporary construction for safety measures, hoists and scaffolds shall be erected in accordance with the General Conditions.

E. Construction yard shall be located on job site. Provide security and safety protection.

F. The obtaining of all utilities for construction, including power and water, shall be the responsibility of the Contractor, and the Contractor shall bear the cost of all utilities used during construction. Cost of all connections and facilities for use of utilities shall be borne by the Contractor.

4.0 PROPERTY PROTECTION

A. Care is to be exercised by the Contractor in all phases of construction to prevent damage and injury to the property of others.

B. In connection with work performed on "private property" (property other than that belonging to the Owner), the Contractor shall confine his equipment, the storage of materials, and the operation of his workmen to the limits indicated on the plans, or to lands and right-of-way provided for the project by the Owner, and shall take every precaution to avoid damage to the private property Owner's buildings, grounds and facilities.

C. Fences, hedges, shrubs, etc. within the construction limits shall be carefully removed, preserved, and replaced when the construction is completed. Where ditches or excavations cross lawns, the sod shall be removed carefully and replaced when the backfilling has been completed. If sod is damaged or not handled properly, it shall be replaced with new sod equal to existing sod at the Contractor's expense. Grassed areas, other than lawns, shall be graded; fertilized and seeded when construction is completed. When construction is completed the private property Owner's facilities and grounds shall be restored to as good or better condition than found as quickly as possible at the Contractor's expense.

5.0 CONFLICT WITH OR DAMAGE TO EXISTING UTILITIES AND FACILITIES

A. Insofar as location data is available to the Engineers, existing underground utilities (such as waterlines, sewer lines, gas lines, telephone conduits, etc.) are accurately located on the drawings. Due, however, to the approximate nature of much of this data, the location of any particular facility cannot be certified to be correct. In general, locations and elevations shown are approximate only.

B. Before proceeding with the work, the Contractor shall confer with all public or private companies, agencies, or departments that own and operate utilities in the vicinity of the construction work. The purpose of the conference is to verify the location of, and possible interference with, the existing utilities that are shown on the Plans, arrange for

necessary suspension of service, and make arrangements to locate and avoid interference with all utilities that are not shown on the Plans.

6.0 CONTROL OF EROSION

A. The Contractor shall be responsible for control of siltation and erosion from the project work. Control shall include all necessary ditching, check dams, mulching, etc. to prevent deposition of materials in roadside ditches. The Owner shall incur no extra costs from such work.

B. For construction projects disturbing an area in excess of 1.0 acre, the Contractor will be required to obtain, administer, and terminate a KPDES Storm Water Discharge Permit. Copies of the permit shall be forward to the Engineer prior to the issuance of the contract Notice to Proceed.

7.0 MEASUREMENT AND PAYMENT

7.1 MEASUREMENT OF QUANTITIES

A. All Work completed under the Agreement will be measured by the Contractor according to United States Standard Measure Units.

B. Unless otherwise specified, measurement of concrete quantities will include only that volume within the neat lines as shown on the Plans or as altered by the Engineer to fit field conditions. The prismoidal formula will be used in computing the volumes of structures, or portions of structures, having end sections of unequal areas.

C. All items which are measured by the linear foot, such as pipe, will be measured along the centerline distance of the installed item with no allowance for connections, fittings or laps at connections.

D. In computing volumes of excavation, borrow and embankments, the average end-area method will be used. For the purpose of ascertaining quantities, it is agreed that the planimeter shall be considered an instrument of precision adapted to the measurement of areas.

7.2 LUMP SUM

A. When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

7.3 ACTUAL QUANTITIES

A. When actual quantities for a specific portion of the Work are designated as the pay quantities in the Contract Documents, they shall be the final quantities for which payment

for such specific portion of the Work will be made. The actual quantities will be determined by field measurements during construction.

7.4 SCOPE OF PAYMENT

A. The contract unit prices whether based on lump sum, actual quantities for the various bid items of the Contract Documents shall be considered full compensation for all labor, materials, supplies, equipment, tools, and all things of whatever nature required for the complete incorporation of the item into the Work.

7.5 PAYMENTS

A. Estimates for payment, partial payments and final payments shall be in accordance with and follow procedures set forth in the General Conditions and Supplementary Conditions.

8.0 ACCESS ROADS

A. The Contractor, Contractor's employees and all trucks delivering equipment, supplies or materials to the project shall use the access roads shown in the Plans for entering and leaving the project sites.

9.0 TESTING & LABORATORY SERVICES

A. GENERAL

Periodic testing shall be performed to determine that materials provided comply with the specified requirements; such testing includes, but is not necessarily limited to:

i. Material Compaction

ii. Cast-In-Place Concrete

iii. Grout

B. RELATED WORK DESCRIBED ELSEWHERE

Requirements for testing may be described in various Sections of these Specifications; where no testing requirements are described, but the Owner decides that testing is needed, the OWNER may require testing be performed under current pertinent standards for testing.

C. SELECTION OF TESTING LABORATORY

The Contractor shall submit the credentials of the testing laboratory to the Engineer for review. Laboratories not qualified to perform the tests will not be approved.

D. CODES AND STANDARDS

Testing shall be conducted in accordance with all pertinent codes and regulations and with selected standards of the American Society for Testing and Materials.

E. TEST RESULTS HANDLING

The Contractor shall promptly process and distribute all required copies of test reports to ensure all necessary re-testing and/or replacement of materials may be accomplished with the least possible delay in progress of the Work.

F PAYMENT FOR TESTING SERVICES

The Contractor shall pay for all testing services required by the specifications. All additional testing beyond the requirements of the specifications and as requested by the Owner will be paid by the Owner.

i. RE-TESTING. When initial tests indicate non-compliance with the Contract Documents, all subsequent re-testing shall be paid by the Contractor.

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

G. COOPERATION WITH TESTING LABORATORY

Representatives of the testing laboratory shall have access to the Work at all times. The Contractor shall provide facilities for such access in order that the laboratory may properly perform its functions.

10.0 SUBMITTALS AND SUBSTITUTIONS

A. GENERAL

The minimum acceptable quality of workmanship and materials may be defined either by manufacturer's name and catalog number or by reference to recognized industry standards. To insure that the specified products are furnished and installed in accordance with design intent, procedures have been established for advance submittal of design data and for its review and approval or rejection by the Engineer.

Contractual requirements for submittals are described in the General Conditions and Supplementary Conditions.

All submittals shall be made electronically using Portable Document Format (PDF). Paper copies will not be accepted.

B. SUBSTITUTIONS

ENGINEER'S APPROVAL REQUIRED. The Agreement is based on the materials, equipment, and methods described in the Contract Documents. The Engineer will consider proposals for substitution of materials, equipment, and methods only when such proposals are accompanied by full and complete technical data and all other information required by the Engineer to evaluate the proposed substitution. Do not substitute materials, equipment, or methods unless such substitution has been specifically approved for this Work by the Engineer.

"OR EQUAL". Where the phrase "or equal" occurs in the Contract Documents, do not assume that material, equipment, or methods will be approved as equal by the Engineer unless the item has been specifically approved for this Work. The decision of the Engineer shall be final.

C. AVAILABILITY OF SPECIFIED ITEMS

The Contractor shall verify, prior to bidding, that all specified items will be available in time for installation during orderly and timely progress of the Work. In the event the specified item or items will not be so available, the Contractor shall notify the Engineer prior to receipt of Bids.

D. IDENTIFICATION OF SUBMITTALS

The Contractor shall completely identify each submittal and resubmittal by showing at least the following information:

i. Name and address of submitter, plus name and telephone number of the individual who may be contacted for further information.

ii. Name of project as it appears in these Specifications.

iii. Drawing number and Specifications Section number to which the submittal applies.

iv. Whether this is an original submittal or resubmittal.

E. COORDINATION OF SUBMITTALS

Prior to submittal for Engineer’s review, the Contractor shall use all means necessary to fully coordinate all material, including the following procedures:

i. Determine and verify all field dimensions and conditions, materials, catalog numbers, and similar data.

ii. Coordinate as required with all trades and with all public agencies involved.

iii. Secure all necessary approvals from public agencies and others and signify by stamp, or other means, that they have been secured.

iv. Clearly indicate all deviations from the Contract Documents.

v. All submittals shall be reviewed by the Contractor prior to submitting to the Engineer. The Contractor shall stamp the submittals showing their approval and comments before submitting to the Engineer.

F. GROUPING OF SUBMITTALS

Unless otherwise specifically permitted by the Engineer, the Contractor shall make all submittals in groups containing all associated items; the Engineer may reject partial submittals as not complying with the provisions of the Contract Documents.

G. TIMING OF SUBMITTALS

The Contractor shall make all submittals far enough in advance of schedule dates of installation to provide all required time for reviews, for securing necessary approvals, for possible revision and resubmittal, and for placing orders and securing delivery. In scheduling, allow at least five full working days for the Engineer's review following his receipt of the submittal.

11.0 INSTALLATION REQUIREMENTS

A. Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the respective manufacturers, unless otherwise specified.

12.0 PROJECT RECORD DOCUMENTS

A. As the Work progresses, the Contractor shall keep a complete and accurate record of changes or deviations from the Contract Documents and the Shop Drawings, indicating the Work as actually installed. Changes shall be neatly and correctly shown on the respective portion of the affected document, using black line prints of the Drawings affected, or the Specifications, with appropriate supplementary notes. This record set of Drawings, Shop Drawings, and Specifications shall be kept at the job site for inspection by the Engineer.

B. The records above shall be arranged in order, in accordance with the various sections of the Specifications, and properly indexed. Prior to application for final payment, and as a condition to its approval by the Engineer, deliver the Record Drawings and Shop Drawings, arranged in proper order, indexed, and endorsed as hereinbefore specified.

C. No review or receipt of such records by the Engineer or Owner shall be a waiver of any deviation from the Contract Documents or the Shop Drawings or in any way relieve

the Contractor from his responsibility to perform the Work in accordance with the Contract Documents and the Shop Drawings to the extent they are in accordance with the Contract Documents.

13.0 PROJECT MEETINGS

A. The Contractor's Superintendent for the Work shall attend all monthly project meetings. A Gantt type construction sequencing schedule shall be prepared, updated, and presented at every monthly project meeting. This schedule shall provide details including the completion percentage of all trades and other major project construction items.

END OF SECTION

SECTION 01453

TESTING AND INSPECTIONS, INCLUDING SPECIAL INSPECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes administrative and procedural requirements for Special Inspection as defined in Chapter 17 of the Kentucky Building Code.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

C. Perform Tests & Inspections as specified.

D. Inspections shall be performed by representatives of the Owner, but Material Testing shall be performed by an independent and qualified consultant. The Contractor shall be select and submit the materials testing consultant's qualifications for approval to the Engineer. The cost for all materials testing shall be included in the Contractor's lump-sum bid for the project.

E. Special Inspection per the Kentucky Building Code is required on the following building structures:

1. Filter Building Addition
2. Chemical Feed Building Addition

F. **ALL OTHER STRUCTURES SHALL BE INSPECTED ACCORDING TO THIS SPECIFICATION, BUT THOSE INSPECTIONS ARE NOT CONSIDERED "SPECIAL INSPECTIONS" AS REQUIRED BY THE BUILDING CODE.** The inspector shall keep non-special and special inspection reports and tests separate and identifiable for recordkeeping purposes.

1.03 SUBMITTALS

A. Overall:

1. Prepare and submit certifications:

a. Contractor’s Statement of Responsibility: Submit before the start of construction, acknowledging the following:

1) Awareness of the special requirements contained in the statement of special inspections.
2) Acknowledgement that control will be exercised by the contractor to ensure conformance with the construction documents.
3) Description of the procedures within the contractor's organization to exercise such control.
4) The method by and frequency of which reports are distributed to the persons in the contractor's organization exercising the control.
5) Identification and qualifications of the persons in the contractor's organization exercising such control and their positions within the organization.

b. Inspector’s Qualifications: Inspection Agency shall submit before the start of construction.
c. Inspector’s Final Certification: Inspection Agency shall submit after completion of inspections.

B. Fabricators:

1. Prepare and submit inspection reports:

a. Inspection of Fabricator’s Quality Control Procedures

2. Prepare and submit certifications:

a. Quality Control Certification
b. Fabrication Quality Control Procedures
c. Fabricators Certificate of Compliance: stating that the work was performed in accordance with the approved construction documents (submitted at the completion of such work).

C. Soils Construction:

1. Prepare and submit test reports:

a. Soil bearing capacity at foundations.
b. Controlled fill density at controlled fill for the structure.

c. Prepare and submit inspection reports:

1) Inspection of Placement of Controlled Fill: Prior to each placement of footing concrete.

D. Concrete Construction:

1. Prepare and submit test reports:

a. Compressive strength, slump, and air content. Concrete shall be tested once per day that concrete is placed plus once for every 100 yards of concrete placed thereafter for each structure.

2. Prepare and submit inspection reports:

a. Inspection of forms, installation of reinforcement and delivery tickets prior to each placement of concrete.

3. Prepare and submit certifications:

a. Cement
b. Aggregate
c. Admixtures
d. Reinforcement

E. Masonry Construction:

1. Prepare and submit test reports:

a. Mortar aggregate ratio and mortar air content: Test each once at beginning of project and once for each 5,000 s.f. of masonry thereafter.

2. Prepare and submit inspection reports:

a. Inspection of mortar proportioning once at beginning of projects and once for each 5,000 s.f. of masonry thereafter.
b. Inspection of placement of masonry, reinforcement, and grout prior to and during each placement of grout.

3. Prepare and submit certifications:

a. Masonry Units
b. Cement for Mortar
c. Sand for Mortar
d. Grout
e. Reinforcement

F. Steel Construction:

1. Prepare and submit inspection reports:

a. Inspection of marking and connection details for all members and connections – verify all steel members are installed in the correct locations and are connected in accordance with the construction documents and approved erection drawings.
b. Inspection of bolt pretensioning for each fully-pretensioned bolted connection.
c. Visual inspection of all non-pretensioned bolted connection.
d. Visual inspection of all field welds.

2. Prepare and submit certifications:

a. Certified Mill Test Reports (MTRs) for steel, bolts, nuts, washers and weld filler metal (for field welds).

G. Wood Construction: (Note: Refer to “Inspection of Fabricators” for wood truss fabrication inspection.)

1. Prepare and submit inspection reports:

a. Inspection of connection of roof trusses to structure.
b. Inspection of all wood framing members for correct size, species, grade, location and connections.
c. Inspection of thickness, grade and fastening of all sheathing.

2. Prepare and submit certifications:

a. Product data with certifications for all wood, sheathing and fasteners.

1.04 QUALIFICATIONS

A. Use a qualified Inspector to perform all Inspections required by this Section.

B. Inspector’s qualifications shall include information which provides evidence of the knowledge and experience necessary to qualify a person as a Inspector for the category of work being certified.

C. The Inspector is a person employed by the Owner.

D. Inspectors perform their duties independent from the construction quality control staff employed by the Contractor.

E. More than one Inspector may be required to provide the varied knowledge and experience necessary to adequately inspect all of the categories of work requiring Inspection.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 DUTIES AND RESPONSIBILITIES OF THE INSPECTOR

A. The Inspector shall observe the Work and review tests performed by the contractor's independent agent to ensure conformance with the design drawings and specifications, and the applicable workmanship provisions of the Kentucky Building Code:

1. Reviewed shop drawings may be used only as an aid to inspection.

a. The Inspector shall observe activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
b. The Special Inspector shall submit timely inspection reports; weekly at a maximum.

B. The Special Inspector shall obtain from the contractor all certifications required to be submitted as part of the inspection requirements (e.g. Contractor's Statement of Responsibility, Fabricators' Quality Control Plans, Material Certifications, etc.) and submit them along with the field inspections and test review that the Inspector performs. Inspection submittals by the Inspector include ALL items included above, not just the ones that the Inspector prepares.

C. The Inspector shall cooperate with the Contractor and provide timely service, keep records of all inspections, and furnish them in a timely manner to the Engineer/Architect, and Contractor as construction progresses.

D. Discrepancies shall be brought to the immediate attention of the Contractor for correction. If discrepancies are not corrected, the discrepancies shall be brought to the attention of the Engineer/Architect prior to the completion of that phase of work.

E. Inspection Reports shall include the following:

1. Name, address, and telephone number of Inspector performing the inspection and making the report.

2. Qualifications and Certifications of the Inspector performing the inspection and making the report.
3. Dates and locations of samples and tests or inspections, date of report.
4. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
5. Description of the Work, identification of products, Specification Section, tests reviewed, and inspection methods.
6. Complete test or inspection data results.
7. Test review and inspection results and an interpretation of test results.
8. Statement on condition of substrates and their acceptability for installation of the next phase of work – according to the Construction Documents.
9. Statement that products being installed at site comply with requirements.
10. Comments and professional opinion on whether tested, inspected, or installed Work complies with the Contract Document requirements.
11. Statement whether conditions, products, and installation may affect warranty of any products installed, according to the Construction Documents.
12. Other required inspections and/or tests indicated in individual Specification Sections.

F. Inspector's Final Certificates shall state that all items requiring Inspection and Testing were fulfilled and are in conformance with the approved design and shop drawings, specifications, approved change orders, and the applicable provisions of the Kentucky Building Code.

1. Items that were not in conformance and any unresolved discrepancies shall be itemized in the report.

a. Final report shall be bound, divided by construction type, and in chronological order.
b. Final Report shall be prepared by, sealed, and signed by the Inspector.

3.02 DUTIES AND RESPONSIBILITIES OF THE CONTRACTOR

A. Notify the Inspector with adequate advance notice when construction is ready to be inspected.

B. Provide Inspector access to plans, specifications, shop drawings, and change orders at the jobsite.

C. Submit required certifications (e.g. Contractor's Statement of Responsibility, Fabricators' Quality Control Plans, Material Certifications, etc.) to Inspector.

D. Provide Inspector access to work, including equipment with operator when necessary. Access to equipment includes, but is not limited to, man lifts, excavation equipment, etc.

E. Provide and make samples of materials to be tested in required quantities.

F. Engage an independent, qualified testing laboratory to perform required tests.

G. Provide storage space for Structural Testing/Inspection Agency's exclusive use, such as for storing and curing concrete testing samples. If required by the Inspector, Contractor shall provide cure box with electricity, water, and blankets for curing concrete specimens.

H. Provide labor to assist the Structural Testing/Inspection Agency in performing tests/inspections.

I. Retain at the jobsite all Inspection records submitted by the Inspector and provide these records for review by the Engineer/Architect and Building Inspector upon request.

J. Maintain a discrepancy log on site. Log shall list each discrepancy documented by the Inspector, state the date of discovery and Inspector's report number. Provide room for the Inspector to sign and date when said discrepancy is corrected. No work containing discrepancy shall be covered prior to having reinspection and approval by the Inspector.

K. Cooperate with the Inspector, Engineer/Architect, and Building Inspector in resolving any Inspection related coordination or quality problems.

L. Resolve non-conforming work before additional work is done that would make it difficult to resolve non-conforming work.

M. Costs of additional retesting that are required due to non-conforming work may be charged to the Contractor.

N. Neither the observation of the Engineer/Architect in the administration of the contract, nor tests/inspections by the Testing/Inspection Agency, nor approvals by persons other than the Engineer/Architect shall relieve the Contractor from his obligation to perform the work in accordance with the Contract Documents.

END OF SECTION

SECTION 01573

FLOATING TURBIDITY CURTAIN

1.0 GENERAL

Floating Turbidity Curtains are temporary control measures used for containing suspended sediment in an area of open water. Open water is described as any perennial water course or water body with 6 inch or greater depth. Floating Turbidity Curtains consist of fabric fastened to a flotation carrier and weighted along the bottom edge. Contractor shall provide, erect and maintain turbidity curtain for all work associated the raw water intake.

2.0 PRODUCTS

A. Floating Turbidity Curtains shall meet the following minimum requirements and manufacturer recommendations:

Table: Floating Turbidity Curtain Requirements

	TYPE	
	Still Water (Type 1)	**Moving Water (Type 2)**
Curtain Fabric Material Type	PVC laminated polyester	Impermeable PVC coated polyester
Mass Per Square Yard	18 oz.	22 oz.
Grab Tensile Strength ASTM D 4632 *	300 lbs.	500 lbs.
Flotation	6” diameter marine quality expanded polystyrene	8” – 12” diameter marine quality expanded polystyrene
Net Buoyancy, Per Foot	13 lbs.	20 lbs.
Top Load Carrying Components	Fabric only	Fabric plus 5/16 inch galvanized steel cable 9,800 lbs. minimum break strength
Ballast, Lbs. Per Foot, Minimum	0.63 lbs./foot enclosed 1/4 inch galvanized chain	0.93 lbs./foot enclosed 5/16 inch galvanized chain
Connection Between Sections	Laced grommets	Aluminum collar reinforced quick disconnects

* Minimum average roll value.

3.0 EXECUTION

A. GENERAL

1. Construct Floating Turbidity Curtain as shown in the contract documents and to the expected water depth plus wave height.

2. On U.S. Army Corps of Engineers regulated waters or other navigable waterways, furnish buoys to mark the ends and special areas for visibility. Place buoys as required for navigational purposes.

3. Floating Turbidity Curtain shall be installed adjacent to planned work area prior to soil disturbance. The curtain shall be installed along the complete work area which is planned to be disturbed and to points 20 feet (6 m) beyond the limits of the area of disturbance and tied into the existing soil bank.

5. Do not discharge water pumped from the work site into an area of unrestrained open water.

6. Control surface drainage prior to entry into the water by installation of appropriate erosion control measures on land.

B. FLOATING TURBIDITY CURTAIN

1. Inspect the containment floating turbidity curtain after heavy winds or major rain storms (1 inch) to check for damage and depth of silt on the bottom of the turbidity curtain. If 2 inches or more of silt is present on top of the turbidity curtain, remove the turbidity curtain and silt as described below and reinstall floating turbidity curtain.

2. Upon completion of the work or when clean-out of containment turbidity curtain is required, remove containment turbidity curtain and contained silt by pulling the top of curtain towards land until it reaches the trench line. Remove entrenched fabric and pull both ends up and out of the water. Dispose of collected silt offsite at an upland, non-wetland location or as approved by the Engineer. Following removal of containment curtain, the hanging curtain shall remain in place for a minimum of 48 hours after which it can be removed, provided all work in the area being protected is completed.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

A. Excavation consists of removal of material encountered to subgrade elevations indicated and approved, and subsequent disposal of materials removed.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of ENGINEER. Unauthorized excavation shall be at Contractor's expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to ENGINEER.
2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by ENGINEER.

C. Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer, who will make an inspection of conditions. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Engineer.

1. Removal of unsuitable material and its replacement as directed will be paid on basis of conditions of the Contract relative to changes in work.

D. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.

E. Structure: Buildings, foundations, slabs, bins, curbs, or other man-made stationary features occurring above or below ground.

1.3 SUBMITTALS

A. Submit manufacturer's standard literature and drawings for materials proposed for use on the Project.

QUALITY ASSURANCE

A. Special Inspection (Kentucky Building Code 2018, Section 1704):

1. Special Inspections to be performed under this contract is listed under General Provisions of Structural Drawings. If special inspection is required, inspector shall inspect all applicable work under this contract and the Contractor is responsible for providing safe access to all areas of work under this contract to be inspected at no additional cost to the Owner or His/Her Agents. No concreting shall take place without written approval of the Special Inspector of Record (SIR). Any progression of work without the approval of the SIR will be subject to demolition at the Contractor's expense.

2. The extent of special inspection to be performed is listed Section 1705 of the Kentucky Building Code 2018 (KBC 2018).

3. The Contractor shall retain the services of an Independent Testing Laboratory and pay for their services to execute all the testing required under this section. Four copies of the test reports shall be sent directly by the Testing Laboratory to the ENGINEER within five working days after performing the tests. All reports submitted shall be signed and stamped by a Professional Engineer registered to practice in the State of Kentucky. The Engineer shall carry professional liability insurance to a minimum limit of $1,000,000 per occurrence and submit Certificate of Insurance with ENGINEER as "Additional Insured" along with the test reports.

1.4 PROJECT CONDITIONS

A. Site Information: The condition and/or characteristics of the soils and rock on the project are unclassified. Contractor may perform test borings and other exploratory operations, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Protection of existing lines and utility structures.

The Contractor shall be responsible for notifying all utilities and have the utility companies locate their facilities within the project limits. Existing utility lines shall be protected from damage during excavation and filling, and if damaged, shall be repaired by the Contractor at his expense. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility.

C. Place protective fencing around all excavations.

D. Cover holes and trenches when work is not in progress.

E. Use of Explosives: Use of explosives is not permitted on this project.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory soil and unsatisfactory soil have been identified in the geotechnical report (attached).

C. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, and natural or crushed sand.

D. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1 - 1/2 inch sieve and not more than 5 percent passing a No. 4 sieve.

E. 1. Backfill and Fill Materials: Satisfactory soil materials free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.

2. Suitable materials for fill shall be on site materials from excavation or borrow approved by the Engineer. The location of borrow will be at the Contractor's option based on the recommendations of the Engineer.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavation consists of removal and disposal of materials encountered when establishing required sub-grade elevations.

3.2 STABILITY OF EXCAVATIONS

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction.

3.3 DEWATERING

A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.4 STORAGE OF EXCAVATED MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade, shape and protect stockpiles for proper drainage and control of moisture content.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.

3.5 EXCAVATION FOR STRUCTURES

A. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.

1. Excavations for footings and foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.7 BACKFILL AND FILL

A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under building pad and grassed areas, use satisfactory excavated, imported or borrow material.
2. Under walks and pavements, use sub-base material on satisfactory excavated, imported or borrow material.
3. Directly under building slabs and steps use drainage and sub-base fill materials.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork.
4. Removal of trash and debris from excavation.
5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.8 PLACEMENT AND COMPACTION

A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

1. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

B. Place backfill and fill materials in layer not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand operated tampers.

C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Geotechnical Engineer if soil density tests indicate inadequate compaction.

1. Percentage of Maximum Density Requirements: Compact soil to less than the following percentages of maximum density, in accordance with ASTM D 1557:

a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 98 percent maximum density.
b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
c. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

F. Remove all abandoned existing utilities and replace with compacted backfill. Plugging of pipes is acceptable as an alternate.

3.9 GRADING

A. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish surface of areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
2. Walks: Finish surface of areas under walks to line, grade and cross-section, and to within not more than 0.10 foot above or below required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade and cross-section, and to within not more than 0.05 foot above or below required subgrade elevation.

C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.10 BUILDING SLAB DRAINAGE COURSE

A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.

B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.

1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.11 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow Testing Laboratory retained by the Contractor to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.
    a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using

ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D 3017.

b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Geotechnical Engineer.

1. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to Geotechnical Engineer.
2. Paved Areas and Building Slab Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.
3. If in opinion of Geotechnical Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.

3.12 EROSION CONTROL

A. Provide erosion control methods in accordance with the requirements of authorities having jurisdiction.

B. Silt and erosion control for the project shall be achieved by placing barrier(s), as necessary, to prevent, or substantially impede, eroded soils from washing away from the project site. The barriers shall utilize porous filter-fabric, 36" wide, 25 mils thick, weighing at least 5.5 oz. per sq. yard, E.O.S: U.S. Sieve 20, Mullen Burst: 540 psi, Tensile Grab: 220 pounds, UV Resistance: 90% after 500 weatherometer hours, as Manufactured by American Excelsior Company, or approved equivalent. Silt-fences for tempoary control at other areas of the site shall utilize porous filter-fabric, 36" wide, 6 mils thick, weighing at least 2.5 oz. per sq. yard, E.O.S: U.S. Sieve 70-100, Mullen Burst: 200 psi, Tensile Grab: 120 pounds, UV Resistance: 90% after 500 weatherometer hours, as Manufactured by American Excelsior Company, or approved equivalent.

Silt check dams shall be constructed from rip-rap sized, durable, rock material. At the conclusion of construction, this rock shall be removed and the areas regraded and vegetated.

3.13 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.

3.14 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off Owner's property.

3.15 SEEDING AND SODDING

A. Upon completion of the installation of the work, the Contractor shall remove all debris and surplus construction materials resulting from the work. The Contractor shall fine grade all the disturbed surfaces around the area of the work in a uniform and neat manner leaving the construction area in a condition as near as possible to the original ground line or to the lines as directed by the Engineer.

B. All graded areas shall be left smooth and thickly sown with a mixture of grasses. The mixture of grasses shall consist of one-third (1/3) Rye grass, one-third (1/3) Kentucky Fescue and one-third (1/3) Kentucky Bluegrass by weight, and shall be applied to the graded areas at a rate of not less than 1 pound of seed per one thousand square feet of area. When the final grading has been completed, the entire graded area to be seeded shall be fertilized with 12-12-12 fertilizer, applied at the rate of 6 pounds per one thousand square feet of area. After the seed and fertilizer have both been applied, the Contractor shall then lightly cover the seed by use of a drag or other approved device. The seeded area shall then be covered with straw to a depth of approximately one inch (1”).

C. Where existing lawns have been disturbed, the existing sod will be removed and stored and replaced to its original position once the work is in place. If the Contractor damages or destroys the original sod, it shall be replaced with a sod having at least 60% good quality Kentucky Bluegrass, strongly rooted and free of pernicious weeds and shall be so laid that no voids occur between strips. When placing sod, it shall be tamped or rolled immediately after it is laid and the finished surface shall be true to grade, even and equally firm at all points. Well screened top soil shall be lightly sprinkled over the sodded areas and shall be raked to insure sealing the sod joints. The sodded areas shall be thoroughly watered. Sod damaged by the Contractor shall be replaced with new sod by the Contractor at no cost to the Owner.

D. The fine grading, seeding, sodding and clean-up shall be considered as incidental expense and shall not be separate pay items.

E. Meadows and hay fields will require replacement in kind unless the Contractor secures a release from the property Owner agreeing to no replacement or alternate replacement.

END OF SECTION

SECTION 02465

DRILLED PIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

B. Installation shall include the furnishing of all labor, materials, equipment and services necessary to mobilize equipment, to excavate, and install end-bearing Drilled Piers to the depths and sizes as indicated on the drawings, or as required. All equipment used for this construction shall be in first-class condition and shall be so maintained and efficiently operated at all times. Drilled Piers shall be installed by a contractor who specializes in Drilled Pier construction. A description of the method proposed to be used in Drilled Pier excavation and installation shall be submitted to the Engineer for approval, in writing, at least 15 days before start of the work.

1.2 DESCRIPTION OF WORK

A. Extent of Drilled Piers is shown on drawings, including locations, diameters of shafts, top elevations, and details of construction. The geotechnical report has a map indicating approximate top of bedrock elevations on the site. The geotechnical report is for reference only.

1.3 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of American Concrete Institute (ACI) “Standard Specification for the Construction of End Bearing Drilled Piers” (ACI 336.1), and as herein specified.

1. Where provisions of above standard conflict with building regulations in effect for this project, building regulations will govern, but only to establish minimum requirements.

B. Drilled Pier Installer Qualifications: Not less than three (3) successfully completed contracts with similar soil conditions, shaft sizes, depths and volumes of work contained in this project. Submit satisfactory proof of

compliance to Engineer.

C. Concrete Testing: All testing shall be in accordance with the provisions of Section “TESTING AND INSPECTIONS, INCLUDING SPECIAL INSPECTION”, except that one strength test shall be made for each 50 cubic yards of concrete or fraction thereof placed in any one day.

1.4 SUBMITTALS

A. Reports: Submit following reports directly to Engineer, with copy to others as designated.

1. Concrete Materials Test Reports as proposed for use in concrete mixes.
2. Preliminary Drilled Pier Report of actual allowable bearing capacity at bottom of each shaft, after testing the bottom shaft at each excavation.
3. Certified Drilled Pier Report for each Drilled Pier, recording actual elevation at bottom and top, elevation of rock, final centerline location at top, variation of shaft from plumb, result of tests performed, actual allowable bearing capacity of bottom, depth of socket, levelness of bottom, elevation of bottom and top of any casing left in place, any unusual conditions, from original design, dates of starting excavation, completion of excavation, inspection, testing, and placement of concrete (include any delays in concreting and location of construction joints in shafts).

1.5 JOB CONDITIONS

A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of continuity of such conditions. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor and are not guaranteed to represent conditions that may be encountered.

B. Additional test borings and other exploratory operations may be made by Contractor, but shall be at no additional cost to Owner.

PART 2 - PRODUCTS

2.1 CONCRETE

A. Concrete work shall conform to the requirements of Section “Cast-In-Place Concrete” for Class A concrete, except the 28-day compressive strength shall

be 4,000 psi, the minimum cementitious materials content shall be 517 lb/cy, and the air content shall be 2% +/- 1%, plus the additional requirements herein specified.

B. Concrete placed by tremie through water shall have one extra sack of cement per cubic yard, up to a level of not less than 10 feet above the initial water level.

PART 3 - EXECUTION

3.1 DRILLED PIER EXCAVATION

A. General: Excavate holes for Drilled Piers to required bearing strata or elevation as shown on drawings. Excavate holes for closely spaced Drilled Piers, and those occurring in fragile or sand stratas only after adjacent holes are filled with concrete and allowed to set.

1. Drilled Pier design dimensions shown are minimums as-installed. The design of Drilled Piers is based on strata bearing capacity provided in the geothechnical report, but is subject to verification by the owner's on-site geotechnical and special inspection representative in the field. If bearing strata is revised based on observed conditions, foundation system will be revised as directed by Engineer. Such revisions will be paid for in accordance with contract conditions relative to changes in work.

B. Construction Tolerances: Locate centerline of Drilled Piers within the following tolerances:

1. Maximum permissible variation of location not more than 1/24th of shaft diameter or 2", whichever is less.
2. Shafts out of plumb, not more than 1.5% of length nor exceeding 12.5% of shaft diameter, whichever is less.
3. Concrete cut-off elevation, plus 1" to minus 3".
4. If above tolerances are exceeded, provide corrective construction to compensate for excessive eccentricity. Submit proposed corrective construction methods to Engineer for approval before proceeding.

C. Temporary Shaft Protections: When required, provide full-length watertight steel casings of sufficient thickness to withstand compressive, displacement and withdrawal stresses and to maintain shaft walls. Temporary casings may be left in place or may be withdrawn as concrete is placed, at Contractor's option.

D. The work of this section includes demolition and removal of all material to install the drilled piers as indicated on the drawings, including existing concrete, rock, rock boulders, and other subsurface obstructions, and such work will not be

considered a change in work.

E. Dewatering: Provide and maintain pumping equipment to keep excavations free of water before placing concrete. If excessive water is encountered and drilling operations must be halted, consult with Engineer before using alternate methods of construction.

1. Conduct water to general site run-off ditches and disposal areas with discharge lines. Provide ditching as required to conduct water to site drainage facilities.
2. Conform to the Sediment and Erosion Control Plan, SWPPP and BMPs for management of water removed from excavations.

F. Inspection: Each Drilled Pier must be inspected and tested before placing concrete.

1. Provide facilities as required to assist inspection and testing of excavations and cooperate with inspecting and testing personnel to expedite work.
2. Notify Engineer and testing facility at least 24 hours prior to time excavations will be ready for inspection and tests.

3.2 REINFORCING STEEL AND DOWELS

A. Fabricate and erect reinforcing cages in shafts as one continuous unit using inner ring resteel. Place reinforcement accurately and symmetrically about axis of hole and hold securely in position during concrete placement.

B. Provide adequate cover of concrete over reinforcement, but do not exceed tolerances for reinforcement placement in so doing. Oversized piers are acceptable to maintain concrete cover, whereas undersized reinforcement cages are not acceptable.

C. Use templates to set anchor bolts, leveling plates and other accessories furnished under work of other sections. Provide blocking and holding devices to maintain required position during concrete placement.

D. Protect exposed ends of dowels and anchor bolts from mechanical damage and exposure to weather.

3.3 CONCRETE PLACEMENT

A. General: Fill Drilled Piers with concrete immediately after inspection and approval by inspection agent. Use protection sheets (cut out to receive concrete) over excavation openings, extending at least 12 inches beyond edge. Place concrete continuously and in a smooth flow without segregating the

mixed materials. Provide mechanical vibration for consolidation of at least top 25 feet of each shaft. Place concrete by means of bottom discharge bucket, flexible drop chute, elephant trunk hopper, or tremie. Use chutes or tremies for placing concrete where a drop of more than 10 feet is required, or pump concrete into place. Place concrete in-the-dry unless placing underwater is acceptable to Engineer. If water occurs, and it is impracticable to dewater Drilled Pier excavation, and reasonable attempts to seal off water flow have failed, allow water level to attain its normal level and place concrete by tremie method. Control placement operations to ensure that tremie is not broken during continuous placing from bottom to top. Other methods of depositing concrete underwater may be used if acceptable to Engineer. Maintain a sufficient head of concrete to prevent reduction in diameter of Drilled Pier shaft by earth pressure and to prevent extraneous material from mixing with fresh concrete. Coordinate withdrawal of temporary casings with concrete placement operations to maintain ahead of concrete approximately above casing bottom. Stop concrete placement at cut-off elevation shown, screed level, and apply a scarified, rough finish.

1. Where cut-off elevation is above ground elevation, form top section above grade and extend shaft to required elevation. Interrupted placing operations of over one-hour duration will require a cold joint installation. Leave resulting shaft surface approximately level and insert steel dowels as shown on drawings. At resumption of concrete placing, clean off surface laitance, roughen as required, and slush with a 1-to-l cement grout or commercial bonding agent before remainder of concrete is placed.

B. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified. When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C), and not more than 80°F (27°C) at point of placement. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Do not use calcium chloride, salt and other mineral containing antifreeze agents or chemical accelerators, unless otherwise accepted by Engineer.

C. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). Mixing water may be chilled or chopped ice may be used to control concrete temperature provided water equivalent of ice is calculated to total amount of mixing water. Place concrete immediately upon delivery. Keep exposed concrete surfaces, and formed shaft extensions, moist by fog sprays, wet burlap or other effective means. Do not use retarding admixtures without acceptance of Engineer.

3.4 FIELD QUALITY CONTROL

A. Sample test concrete for quality control during placement, as follows:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
3. Air Content: ASTM C 231, pressure method; one for each set of compressive strength test specimens.
4. Compression Test Specimens: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
5. Concrete Temperature: Test when air temperature is 40°F (4°C) and below, and when 80°F (27°C) and above; and each time a set of compression test specimens made.
6. Compressive Strength Tests: ASTM C 39; one set for each 50 cubic yards or fraction thereof placed in one day. One specimen tested at 7 days, 2 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

    a. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
    b. Report test results in writing to Engineer and Contractor on same day tests are made. Include in reports project identification name and number, date of concrete placement, name of contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type, location of Drilled Pier, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day test and 28-day tests.

7. Additional Concrete Tests: Testing service may take core samples of in-place concrete when test results are such that there is reasonable doubt specified concrete strengths have not been attained.

    a. Complete continuous coring of Drilled Piers may be required at Contractor’s expense, where time for removal of temporary casings exceed specified limits, or where observations or placement operations indicate cause for suspicion of quality of concrete, presence of voids, segregation or other possible defects.

8. Inspection and Tests for Drilled Pier: Soil testing facility shall perform and report specified tests and additional tests which may be required. Conduct tests and provide reports as soon as possible to not delay concreting operations for acceptable excavations. Bottom elevations and bearing capacities and lengths of Drilled Piers as shown on drawings are estimated from available soil data. Actual elevations, Drilled Pier lengths, and bearing capacities will be determined by soil testing facility from conditions found in excavations. Final evaluations and acceptance of data will be determined by Engineer.
9. Drilled Piers Bearing on Rock: Inspect and test each Drilled Pier bottom by drilling and probing to a depth of 5'-0" below bottom elevation to determine whether voids, clay seams, or solution channels exist. Inspection and probing of rock to be performed by testing facility; condition of rock to be approved log testing facility before concrete placement can begin.

A. Owner will engage a qualified inspecting agency to perform inspections and review tests performed by contractor's independent testing agent.

END OF SECTION

SECTION 02513

ASPHALT CONCRETE PAVING

1.0 QUALITY ASSURANCE

1.01 REFERENCES

A. Kentucky Standard Specifications for Road and Bridge Construction, latest edition (KS).

B. Asphalt Institute:

1. AI MS-2 – Mix Design Methods for Asphalt Concrete and other Hot-Mix Types.
2. AI MS-19 – Basic Asphalt Emulsion Manual.

2.0 SUBMITTALS

2.01 Provide copies of materials certificates signed by material producer and Contractor certifying that each material item complies with, or exceeds, specified requirements.

2.02 Provide product and material data, and design mix for each layer of material: sub-base, base course asphalt, wear course asphalt.

3.0 PRODUCTS

3.01 Provide plant mixed, hot laid asphalt-aggregate mixture complying with ASTM D 3515 and as recommended by local paving authorities to suit Project conditions:

A. Base Course with 3.0-6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

B. Binder Course with 4.5-6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

C. Wear Course with 5-7 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

3.02 Sub-base shall be dense graded aggregate, naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag and natural or crushed sand, complying with Section 805 of Kentucky Standard Specifications for Road and Bridge Construction.

3.03 Tack coat and primer asphalt shall be provided as required per Kentucky Standard Specifications.

3.04 Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid or wadable powder form, as manufactured by BASF, Dow Chemical U.S.A., or equal.

3.05 Lane Marking Paint: Chlorinated rubber alkyd type, AASHTO M 248 (FS TT-P-115), Type III.

3.06 Pipe bollards – 6'' diameter steel pipe x 7'-0'' long, hot dipped galvanized, set in 24'' diameter x 36'' deep hole, and backfilled with concrete. Bollard shall also be filled with concrete. Bollard shall have a finished height of 4'-0" above final grade.

3.07 Wheel Stops: Precast of 3,500 psi air entrained concrete, approximately 6'' high, 9'' wide and 7'0—long, with chamfered corners and drainage slots on underside, and anchor holes 1'' diameter, placed vertically, 2'' from each end.

4.0 EXECUTION

4.01 SITE CONDITIONS

A. Contractor shall inspect existing conditions at site relative to previous excavation and grading, as well as site preparation by others, and report any unacceptable conditions to the Architect in writing prior to beginning work. Beginning Work will indicate acceptance of existing conditions as satisfactory for completing the Work, and no claim for additional costs relative to preparation, repair, or modification of previous work will be allowed because of those conditions.

B. All preparation of subgrade, placement of gravel, and paving shall be in accordance with Kentucky Standard Specifications for Road and Bridge Construction.

C. Establish and maintain required lines and elevations.

D. Apply prime and tack coats when ambient temperature is above 50°F (10°C), and when temperature has not been below 35°F (1°C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.

E. Construct asphalt concrete surface course when atmospheric temperature is above 40°F (4°C), and when base is dry. Base course may be placed when air temperature is above 35°F (2°C) and rising.

4.02 INSTALLATION

A. Place wetted sub-base in two (2) lifts, minimum thickness after compaction with 10 ton roller: 10'' at main drive, loading and service areas for trucks or busses, 8'' typical at parking area for passenger cars. Compact/consolidate each layer to density of 84% or greater, of solid volume throughout layer. Additional wetting of base course during compaction may be required.

B. If Owner has employed or required a testing agent, each layer of sub-base should be tested in increments of 2,000 square feet to ascertain proper consolidation has been reached. Testing shall be performed just prior to beginning asphalt coating. If no testing agent is employed, proof roll area to be paved prior to placing subbase and again after placing subbase. Provide proof rolling of prepared soil sub-base, and later on aggregate course in addition to testing at Owner's request.

C. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

D. Provide and install asphalt primer and/or tack coat as required by Asphalt Institute or Kentucky Standard Specifications for current job conditions.

E. Place asphalt concrete mixture on prepared surface, spread and strike off. Spread mixture at minimum temperature of 225 degrees F (107 degrees C). Place inaccessible and small areas by hand. Place binder course of 3'' compacted thickness, wear course of 2'' compacted thickness, to required grade and cross section.

F. Provide paving and base at all drives and parking areas not indicated to be concrete.

G. Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hand tampers or vibrating plate compactors in areas inaccessible to rollers. Accomplish breakdown or immediately following rolling of joints and outside surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material. Follow breakdown rolling as soon as possible while mixture is hot. Continue second rolling until mixture has been thoroughly compacted. Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

H. Remove and replace paving in areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

I. After final rolling, do not permit vehicular traffic on pavement until it has cooled to less than 140°F and hardened. Erect barricades as required.

J. Sweep and clean surface to eliminate loose material and dust. Layout lines and areas to be painted, and obtain approval from ENGINEER prior to paint application.

K. Apply 1 coat of traffic and lane marking paint according to manufacturer's recommendations for application, and at locations indicated on Contract Drawings (mark between designated spaces; i.e., "X" spaces at 9') whether or not specifically noted to paint lines on drawings. Use mechanical equipment to produce uniform, straight edges with 4'' – wide lines.

L. Repairs and patching to existing pavement made necessary by either damage from construction equipment during the work on this project, or by cutting existing paving as part of utility installation, shall be performed in steps similar to those described herein. Cut out all areas to be repaired with saw to provide straight lines on all sides.

M. Contractor shall make repairs to correct non-compliance with tolerances or with water drainage, in accordance with cited specification.

N. Install bollards at locations indicated.

O. Install wheel stops at each new parking space indicated in the area of construction. Set typically 2' from wheel face to edge of pavement. Secure wheel stops to concrete surface with not less than two ¾'' diameter galvanized steel dowels. Length of dowel to penetrate at least 6'' into soil sub-base. Drill placement holes oversize and embed dowels in hot grout material.

4.03 FIELD QUALITY CONTROL

A. Test in place asphalt concrete courses for compliance with requirements for thickness and surface smoothness (using 10' straightedge) to the following tolerances:

Base course thickness ½''
Wearing course thickness – ¼''
Base course surface ¼''
Wearing course surface 3/16''
Crown surface variance ¼''

B. Test aggregate course for minimum density at least one test every 2,500 s.f.

4.04 Paving slope should drain water from surface.

5.0 MEASUREMENT AND PAYMENT

Payment will be made on the basis of the unit price per square foot as contained in the Bid Schedule, subject to any limitations specified in the Contract Documents.

END OF SECTION

SECTION 02820

CHAIN LINK FENCING

1.0 GENERAL

1.1 SCOPE

The CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install zinc coated chain link fence, gates, and hardware, in accordance with the plans.

1.2 QUALITY ASSURANCE

The CONTRACTOR and product manufacturer shall comply with applicable provisions and recommendations of the following:

A. All fencing materials shall conform to applicable portions of the Standards of the Chain Link Fence Manufacturers Institute (CLFMI). Material for framework shall conform to all applicable requirements of the latest ASTM Standard Specifications.

B. Latest revision of ASTM F567 Installation of Chain Link Fence.

C. Latest revision of ASTM A392 Standard Specification for Zinc-Coated Steel Chain Link Fence.

D. Latest revision of ASTM A121 Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

C. Conform to the Kentucky Transportation Cabinet Regulations.

D. Take field measurements prior to preparation of Shop Drawings and fabrication where required, to ensure proper fitting of the work.

1.3 SUBMITTALS

The CONTRACTOR shall submit for approval Shop Drawings for the fabrication and erection of all work. Include plans, elevations, and details of sections and connections.

The CONTRACTOR shall submit the manufacturer’s specifications, anchor details and standard installation details.

2.0 DESCRIPTION

2.1 CHAIN LINK FENCE

Fencing shall be of non-climbable type as manufactured by Southwestern Wire, Inc., or approved equal. It shall be standard overall height of six (6) feet and constructed of chain link fabric with three rows of barb wire on top of steel brackets. Chain link fabric shall be one foot less than complete overall height of fence. Finished height of chain link fence, including barbed wire strands shall be 7'-0", or as indicated in the plan details.

2.2 GATES

Vehicular gates shall be as shown on the DRAWINGS.

2.3 MATERIAL

A. Use Class 2 zinc hot dipped; galvanized after weaving coated, No. 9 Gauge, 0.148-inch nominal diameter wire woven in 2-inch mesh. The fabric shall have a knuckled selvage along the top rail and a twisted and barbed selvage at the bottom. The barbing shall be done by cutting the wire on a bias, creating sharp points. Fence fabric shall be 72" high, or as shown on the plan details.

B. End, corner, angle, and pull posts shall be 3-inch outside diameter, standard (Schedule 40) tubular steel weighing not less than 5.79 pounds per linear foot.

C. Line posts shall be 2-1/2-inch outside diameter, standard tubular steel pipe weighing 3.65 pounds per linear foot.

D. Top rail shall be 1-5/8-inch outside diameter standard steel pipe weighing 2.27 pounds per linear foot. Top rails shall be provided with expansion rail couplings spaced at not less than 20 foot intervals.

E. Gate posts for pedestrian gates shall be 3-inch outside diameter, standard steel pipe weighing 5.79 pounds per linear foot. Gate posts for vehicular gates shall be 4-inch outside diameter, standard steel pipe weighing 9.1 pounds per linear foot. Braces shall be provided at all corners and wherever fabric is not continuous, such as at gates or at other openings. Braces shall be of the same material as the top rail.

F. Extension arms on intermediate posts shall be of pressed steel. Extension arms on end and corner posts shall be heavy malleable iron. Extension arms shall carry 3 barbed wires. Fittings used in connection with the fence and gates shall be malleable iron or pressed steel.

G. Barbed wire shall be four-point pattern, two strand, No. 12-1/2 gauge steel wire, Class 3 hot dipped galvanized after weaving, with large barbs placed 5 inches apart.

H. A 2-inch padlock and chain shall be furnished with each gate. Two keys shall be furnished with each padlock. Chain shall be welded to the gate.

I. Gate frames shall be 2-inch outside diameter pipe weighing 2.72 pounds per linear foot. Corner fittings shall be heavy, malleable iron castings or pressed steel. Fabric shall be the same as in fence. Each gate frame shall be equipped with 3/8-inch diameter adjustable ball-and-socket hinges, catch and stops. Double gates shall have center rests. Hinges shall provide for swinging the gate open through an arc of not less than 180 degrees. Gates shall be suitably braced and reinforced to prevent sagging. Double gates shall be provided with center drop rod, catch and semi-automatic outer catches to secure gate in opened position.

All materials entering into the construction of required fencing shall have minimum Class 2 zinc galvanized coating by the hot dip process.

3.0 INSTALLATION

The Contractor will construct fencing as indicated on the plans. All fencing to be installed shall be new material. Manufacturers recommended installation should be utilized in the placement of fencing. It shall be the responsibility of the CONTRACTOR to verify all dimensions for the fencing.

End, corner and gate posts shall be set in a concrete base not less than 18 inches in diameter which shall extend at least six inches below the bottom of the post. The post shall extend to a depth of at least three feet below the surface of the ground. A brace shall be spaced midway in height of each end, corner and gatepost and shall extend to the first line post. Braces shall be securely fastened to posts by means of malleable iron connections and trussed from line post back to end, corner or gatepost with a 3/8-inch diameter rod.

Line posts shall be set in a concrete base not less than 10 inches in diameter, which shall extend at least six inches below the bottom of the post. The post shall extend to a depth of at least thirty inches below the surface of the ground. Line posts shall be equally spaced along the line of fence at intervals not to exceed ten (10') feet.

Galvanized steel pipe sleeves, 4-inch O.D. for corner, pull and gate posts and 3 1/2-inch O.D. for line posts shall be embedded in concrete as shown on the plans for all fence posts to be installed on concrete structures.

Top rail shall be installed between line posts. Fabric shall not be erected until concrete has had sufficient time to cure. Chain-link fabric shall be stretched to uniform tightness

on the outside of the posts with suitable tools and shall be attached with No. 6 gauge galvanized wire clips securely clinched and attached by means of adjustable clamps. Fabric shall be fastened to line posts at 14-inch intervals. Fabric shall be attached to rail at 24-inch intervals by galvanized tie wires.

A No. 9 coil spring galvanized tensioning wire shall be stretched along the bottom of the fence and securely fastened to the posts. The chain-link fabric shall be attached to the tension wire at intervals not to exceed two feet.

4.0 MEASUREMENT AND PAYMENT

No separate measurements or payment will be made for the chain link fence, gates, and hardware. Payment for this item shall be included in the work to which it is subsidiary in the Bid Schedule.

END OF SECTION

SECTION 03310

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all cast-in-place concrete as indicated on the Drawings and specified herein.

B. All concrete construction shall conform to all applicable requirements of ACI 301 (latest), Specifications for Structural Concrete for Buildings, except as modified by the supplemental requirements specified herein.

C. 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. 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.

1.02 ACTION SUBMITTALS

The Contractor shall submit the following data for Engineer's review in accordance with Section 01340.

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at the Project site.

2. Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. This shall include at least 3 tests each for 7 day and 28 day compressive strengths for test cylinders made and cured in accordance with ASTM C192/C192M and tested in accordance with ASTM

C39/C39M. Include mill test and all other tests for cement, fly ash, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained versus sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

3. Use a qualified independent testing agency for testing for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

C. Slab and Wall Construction Joint Layout Drawings: The Contractor shall submit for review drawings, separate from the steel reinforcing drawings, showing the location of all proposed construction joints and the sequence of concrete placements. Layout plans shall specifically detail methods and sequences of concrete placements for concrete slabs and walls. Include proposed concrete screed equipment, location of waterstops, and/or any proposed deviations from joints indicated on the contract drawings. Indicate all proposed construction joints required to construct the structure. Location of construction joints is subject to approval of the Engineer.

D. Form Ties: Submit product data and dimensions and details of form ties for approval.

E. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Shop drawings shall conform to the latest edition ACI detail manual SP-66. Shop drawings shall be prepared under the direct supervision of a professional engineer licensed in the state in which the project is located and shall include plans, elevations, sections, details, and attachments to other work. Laps of reinforcement at joints shall be coordinated with the Construction Joint Layout Drawings above.

F. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements.

1. Cementitious materials.

2. Aggregates: Test results showing compliance with required standards, i.e. sieve analysis, aggregate soundness tests, petrographic analysis per ASTM C295/C295M, alkali-aggregate reactivity per ASTM C1260, mortar bar expansion testing per ASTM

C1567, etc. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity. Submit Certification of Compliance for freeze-thaw resistant concrete aggregate.

3. Admixtures: Include 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. Include certification that admixtures meet the requirements of NSF / ANSI 61.

    a. Fly Ash: Submit test results in accordance with ASTM C618 for fly ash. Submit test results performed within 6 months of submittal date. Submit manufacturer's policy statement on fly ash use in concrete.

4. Curing Compounds.

5. Trial Batches: For each of the preliminary concrete mix designs and shall include slump per ASTM C143, air content per ASTM C231, unit weight per ASTM C138 and compressive strength tests.

6. Steel Reinforcement: Submit material test results.

7. Field Test of Fresh Concrete: Obtain at least one composite sample for each 50 cubic yd, or fraction thereof, of each concrete mixture placed in any one day. Test fresh concrete in accordance with ACI 301 for compressive strength, slump, and air content.

8. Submit copies of Delivery Tickets of concrete with field test reports. All field test reports and tickets shall be referenced in writing to the location that the subject concrete was placed.

G. Leakage Test Reports: All water holding structures shall be tested separately for leakage by Contractor.

H. Field Quality-Control Reports. Contractor shall submit a signed, dated checklist for each concrete placement that indicates that the forms, reinforcement, and embedded items were independently checked by his quality control person for proper installation prior to placing concrete.

I. Manufacturer Certification: Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".

J. Testing Reports: For all required tests. This includes temperature logs for cold weather concrete operations.

1.03 QUALITY ASSURANCE

A. Qualification Data: Comply with the following including all sub-references contained herein unless modified by requirements in the Contract Documents:

1. ACI 301, “Specifications for Structural Concrete”.

2. ACI 318, “Building Code Requirements for Structural Concrete”.

3. ACI 117, “Specifications for Tolerances for Concrete Construction and Materials”.

4. CRSI 10MSP, “Manual of Standard Practice”

5. ASTM E329, “Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction”.

6. NSF / ANSI 61 “Drinking Water System Components.”

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products that complies with ASTM C94/C94M requirements for production facilities and equipment and is certified according to NRMCA CPMB 100.

C. Welding Procedure Qualifications: Must be in accordance with AWS D1.4/D1.4M.

D. Welder Qualifications: Provide certificates in accordance with AWS D1.4/D1.4M or under an equivalent qualification test approved in advance. Welders are permitted to do only the type of welding for which each is specifically qualified.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer’s plant, obtain aggregate from a single source, and obtain admixtures from single source from single manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING/PROJECT CONDITIONS

A. Reinforcing Steel:

1. 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.

2. 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.

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

4. 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 a delay in depositing concrete, reinforcing shall be reinspected and, if necessary, recleaned.

B. Joint Sealers:

1. Do not proceed with installation of joint sealers when ambient and substrate temperature conditions are outside the limits permitted by the joint sealer manufacturer. Do not install joint sealers when joint substrates are wet due to rain, frost, condensation or other causes.

2. Do not proceed with installation of joint sealers when joint widths are less than allowed by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.01 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed, ASTM A706 Grade 60 where required to be welded.

B. All bar reinforcing 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.

C. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs. Dowels shall be installed at right angles to construction joints and expansion joints. Dowels shall be accurately aligned parallel to the finished surface, and shall be rigidly held in place and supported during placing of the concrete. One end of dowels shall be oiled or greased or dowels shall be coated with high density polyethylene with a minimum thickness of 14 mils.

2.02 ANCHOR RODS

A. Unheaded Anchor Rods: ASTM F1554, Grade 36.

1. Configuration: Straight, threaded each end with three sets nut and washer each as indicated.

2. Nuts: ASTM A563 heavy-hex carbon steel.

3. Washers: ASTM F436, Type 1, hardened carbon steel plus A 36 plate washers where indicated.

4. Finish: As indicated.

2.03 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice", of greater compressive strength than concrete and as follows:

1. Reinforcement supports and other accessories in contact with the forms for members which will be exposed to view in the finished work shall be of stainless steel or shall be plastic. Supports for reinforcement, when in contact with the ground or stone fill, shall be precast stone concrete blocks or plastic. Particular attention is directed to the requirement of Paragraph 3.3.2.4 of ACI Standard 301. These requirements apply to all reinforcement, whether in walls or other vertical elements, inclined elements or flatwork.

2. Particular care shall be taken to bend tie wire ends away from exposed faces of beams, slabs and columns. In no case shall ends of tie wires project toward or touch formwork.

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.

C. 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.

2.04 FORMWORK

A. Formwork shall conform to ACI SP-4.

B. Forms for exposed concrete surfaces shall be exterior grade, high-density overlay plywood, steel, or wood forms with smooth tempered hard-board form-liners.

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

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

E. 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 1/600 of the span between structural members.

F. Form-Release Agents: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

G. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Shall be one of the following:

1. Taper ties that can be removed from the concrete wall after the forms have been stripped, and that have an elastomeric plug seal to place in the hole after the tie is removed.

2. Snap ties that remain in the wall and he ends can be snapped off at least 1½ inches below the surface of the concrete. Snap ties shall have integral water stops.

3. She-bolts with ends at least 1½ inches below the surface of the concrete.

4. Coil ties with ends at least 1½ inches below the surface of the concrete.

I. Form Ties for water-retaining structures shall have integral waterstops.

J. Flat or strap ties are not permitted.

2.05 HYDRAULIC CEMENT

A. Portland Cement: ASTM C150, Type I/II. Type III may only be used with Engineer's written approval.

B. When potentially reactive aggregates are to be used in the concrete mix, cement shall meet the following requirements:

1. For concrete mixed with only Portland Cement, the total alkalis in the cement (calculated as the percentage of NA2O plus 0.658 times the percentage of K20) shall not exceed 0.40%.

2. For concrete mixed with Portland Cement and an appropriate amount of fly ash the total alkalis in the Portland Cement (calculated as the percentage of NA20 plus 0.658 times the percentage of K20) shall not exceed 0.85%.

3. When non-reactive are used in the concrete mix, total alkalis 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.

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.

2.06 FLY ASH

A. Fly Ash: ASTM C618, Class F with a maximum LOI of 6%, a maximum free carbon content of 3.0% and a maximum available alkali content (as Na_2O) of 1.5%.

B. Where reactive aggregates 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.

C. For concrete to be used in environmental concrete structures, i.e. process structures or fluid containing structures, the inclusion of fly ash in the concrete mix is mandatory.

2.07 WATER

A. Water: ASTM C94/C94M

B. 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.

2.08 AGGREGATES

A. Normal-Weight Aggregates: ASTM C33.

B. Fine aggregate (sand) in the various concrete mixes shall consist of natural or manufactured sand, clean and free of deleterious substances, and conforming to ASTM C33.

C. Coarse aggregates shall consist of hard, clean, durable gravel, crushed gravel or crushed rock. Coarse aggregate shall be size #57 or #67 conforming to ASTM C33.

1. Supplier shall certify that coarse aggregate source has a demonstrated history of not causing alkali silica reaction in concrete.

D. Provide aggregates from a single source.

E. Aggregates shall be tested for gradation by sieve analysis tests in conformance with ASTM C136.

F. Aggregates shall be tested for soundness in accordance with ASTM C88. 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. Fine and coarse aggregates shall be tested and evaluated for alkali-aggregate reactivity in accordance with ASTM C1260. The fine and coarse aggregates shall be evaluated separately and in combination, which matches the Contractor's proposed mix design proportioning. All results for the separate and combination testing shall have a measured expansion less than 0.008 percent at 16 days after casting. Should the test data indicate an expansion of 0.08 percent or greater, the aggregate shall be rejected or additional testing using ASTM C1260 and ASTM C1567 shall be performed. The additional testing using ASTM C1260 and ASTM C1567 shall be performed using the low alkali Portland cement in combination with Class F fly ash. Class F fly ash shall be used in the range of 25 to 40 percent of the total cementitious material by mass.

2. A petrographic analysis in accordance with ASTM C295 shall be performed to identify the constituents for the fine and coarse aggregate. Non-reactive aggregates shall meet the following limitations:

   a. Optically strained, microfractured, or microcrystalline quartz, 5.0% maximum.

   b. Chert or chalcedony, 3.0% maximum.

   c. Tridymite or cristobalite, 1.0% maximum.

   d. Opal, 0.5% maximum.

   e. Natural volcanic glass in volcanic rocks, 3.0% maximum.

3. Proposed concrete mix including proposed aggregates shall be evaluated by ASTM C1567. 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 form TC 64-764 certifying that all aggregates used for this Project meet the Kentucky Department of Highways' requirements for freeze-thaw resistance.

J. Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

2.09 ADMIXTURES

A. General: All admixtures shall conform to NSF / ANSI 61.

B. Air-Entraining Admixture: ASTM C260.

C. Air entraining agent shall be added to all concrete unless noted otherwise. Air content of concrete, when placed, shall be within the ranges given in the concrete mix design.

D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

2. Retarding Admixture: ASTM C494/C494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.

4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.

5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

E. The admixture manufacturer, when requested, shall provide a qualified concrete technician employed by the manufacturer to assist in proportioning concrete for optimum use. He shall also be available when requested to advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing job conditions.

F. Admixtures containing calcium chloride, thiocyanate or more than 0.05 percent chloride ions are not permitted.

G. The addition of admixtures to prevent freezing is not permitted.

H. The use of admixtures to retard setting of the concrete during hot weather, to accelerate setting during cold weather, and to reduce water content without impairing workability will be permitted if the following conditions are met:

1. The admixture shall conform to ASTM C494, except that the durability factor for concrete containing the admixture shall be at least 100 percent of control, the water content a maximum of 90 percent of control and length change shall not be greater than control, as defined in ASTM C 494.

2. Where the Contractor finds it impractical to employ fully the recommended procedures for hot weather concreting, the Engineer may at his discretion, require the use of a set retarding admixture for mass concrete 2.5 feet or more thick for all concrete whenever the temperature at the time concrete is cast exceeds 80°F. The admixture shall be selected by the Contractor subject to the review of the Engineer. The admixture and concrete containing the admixture shall meet all the requirements of these Specifications. Preliminary tests of this concrete shall be required at the Contractor's expense.

2.10 CLASSES OF CONCRETE AND USAGE

A. Structural concrete of the various classes required shall be proportioned by either Method 1 or Method 2 of ACI 301 to produce the following 28-day compressive strengths:

1. Selection of Proportions for Class A Concrete:

a. 4,500 psi compressive for strength at 28 days.

b. Type I/II cement plus supplementary cementitious materials.

c. Maximum water-cementitious materials ratio = 0.45.

d. Min. cement content = 564 lbs.

e. Nominal max. size coarse aggregate = No. 67 (3/4" max.) or No. 57 (1" max.). Walls with architectural treatment shall use #67 stone.

f. Air content = 6% plus or minus 1% by volume for exterior concrete, except interior smooth finished slabs shall have 2% plus or minus 1% by volume.

g. Fly Ash = 25% maximum.

h. Slump = 3" - 4" when tested in accordance with ASTM C 143/C 143M. Slump shall not exceed 8 inches when high-range water-reducers are used.

2. Selection of Proportions for Class B Concrete:

a. 3,500 psi compressive strength at 28 days.

b. Type I/II cement plus supplementary cementitious materials.

c. Max. water-cementitious materials ratio = 0.50.

d. Min. cement content = 470 lbs. (5.0 bags)/cu. yd. concrete.

e. Nominal max. size coarse aggregate = No. 67 (3/4" max.) or No. 57 (1" max). Walls with architectural treatment shall use No. 67 (3/4" max.).

f. Air content = 6% plus or minus 1% by volume if exposed to freezing and thawing.

g. Slump = 3" - 4" when tested in accordance with ASTM C 143/C 143M. Slump shall not exceed 8 inches when high-range water-reducers are used.

B. Concrete shall be used as follows:

1. Class A concrete for all concrete work except as noted below.

2. Class B non-structural concrete for fill concrete, thrust blocks, and where indicated on the Drawings.

2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type I, Class B, dissipating.

2.12 RELATED MATERIALS

A. Bonding Agents: ASTM C1059-C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.

C. Expansion Joint Filler: Preformed, compressible, resilient, non-waxing, non-extruding strips of plastic foam of material and size, shape and density to control sealant depth and otherwise contribute to producing optimum sealant performance. Provide either flexible, open cell polyurethane foam or non-gassing, closed-cell polyethylene foam, unless otherwise indicated, subject to approval of sealant manufacturer.

D. Joint Sealants: ASTM C920, Type M, Class 25, Use T, M, A, I. Use non-sag type on vertical surfaces.

E. Polyvinyl Chloride (PVC) Waterstops:

1. PVC waterstops for construction joints shall have width and shape as indicated on the drawings with a minimum thickness at any point of 3/8 inches.

2. Waterstops for expansion joints shall have width and shape as indicated on the drawings with a minimum thickness at any point of 3/8 inches.

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

a. Tensile Strength = 1750 psi (ASTM D638)

b. Ultimate Elongation = not less than 280% (ASTM D638)

4. 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.

5. Waterstops shall be securely wired into place to maintain proper position during placement of fresh concrete, as shown on the Drawings. Care shall be taken in the installation of the waterstop and the placing of the concrete to avoid "folding" while concrete is being placed, and to prevent voids in the concrete surrounding the waterstop.

F. Chamfer strips shall be one (1) inch radius with leg, polyvinyl chloride strips by Gateway Building Products, Saf-T-Grip Specialties Corp., Vinylex Corp., or equal.

PART 3 - EXECUTION

3.00 EXCAVATION FOR STRUCTURAL CONCRETE FOOTINGS & SLABS

A. All excavations for structural concrete footings and slabs shall be flat, smooth and level unless indicated otherwise.

B. Excavations for structural concrete footings & slabs shall be eight inches (8”) deeper than the bottom of structural concrete and filled with eight inches (8”) of compacted #57 crushed limestone aggregate leveling course.

C. The tolerance for the bottom of the excavation elevation shall be plus zero inches and minus three inches (+ 0” / -3”) and the tolerance for the elevation of the top of the crushed stone leveling course shall be plus zero inches and minus one inch (+ 0” / -1”).

3.01 STEEL REINFORCEMENT

A. General: Comply with CRSI’s “Manual of Standard Practice” for placing reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Reinforcement bars shall not be straightened or rebent in a manner that will injure the material. Heating of bars is not permitted.

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

3.02 FORMWORK

A. 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. 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. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete.

D. Forms shall be mortar tight so as to prevent the loss of water, cement and fines during placing and vibrating of the concrete.

E. All forms shall be constructed in such a manner that they can be removed without hammering or prying against the concrete. Forms shall not be disturbed until the concrete has attained sufficient strength. Forms shall be removed in such manner as not to impair safety and serviceability of the structure. Care shall be taken to prevent chipping of corners or other damage to concrete when forms are removed. Exposed corners and other surfaces which may be damaged by ensuing operations shall be protected from damage by boxing, corner boards or other approved means until construction is completed.

F. Forms shall be coated with an approved release agent before initial pour and between subsequent pours, in accordance with the manufacturer's printed instructions. Form boards shall not be wet prior to placing concrete.

3.03 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Construction joints shall be positioned so as not to adversely affect the structural performance.

5. 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.

C. Expansion Joints: 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.

D. Contraction Joints in Slabs: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

E. Isolation Joints in Slabs: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated:

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

F. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.04 CONCRETE MIXING

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: Measure, batch, mix, and deliver concrete according to ASTM C94, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2. Any truck delivering concrete to the job site, which is not accompanied by a delivery ticket showing the following information will be rejected and such truck shall immediately depart from the job site:

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

g. Weight in pounds of coarse aggregate

h. Air entraining agent, brand, and weight in pounds and ounces

i. 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. Time of loading

m. Time of delivery to job (by truck driver)

C. Project Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. Scales for weighing concrete ingredients shall be accurate when in use within +/- 0.04 percent of their total capacities. Standard test weights shall be available to permit checking scale accuracy.

2. The concrete shall be mixed in a batch mixer capable of thoroughly combining the aggregates, cement, and water into a uniform mass within he 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 within.

3. The interior of the mixer shall be free of accumulations that will interfere with mixing action. Mixing blades shall be replaced when they have lost 10% if their original height.

4. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at lease 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.

5. For mixer capacity larger than 1 cu. Yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd.

6. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

7. Concrete shall be mixed only in quantities for immediate use and within the time and mixing requirements of ASTM C94.

3.05 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. If concrete is placed by pumping, no aluminum shall be used in any parts of the pumping system which contact or might contaminate the concrete. Aluminum chutes and conveyors shall not be used.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Engineer.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation:

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.

2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. All construction joints shall be prepared for bonding by roughening the surface of the concrete in an acceptable manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. Joints in walls and columns shall be maintained level. Concrete shall be placed in layers not over 18 inches deep and each layer shall be compacted by mechanical internal-vibrating equipment supplemented by hand spading, rodding and tamping as directed. Vibrators shall not be inserted into lower courses that have begun to set.

G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

4. Temperature monitoring and recording of concrete that has been placed or will cure in cold weather conditions is required. Place temperature monitors in quantities and locations as directed by Engineer. Temperature monitors shall be electronic and temperature data shall be transmitted to the internet and available for both Contractor and Engineer to view online in real-time. Temperature shall be logged and logs shall be submitted to Engineer at completion of curing for each cold weather placement.

I. All construction joints shall be prepared for bonding by roughening the surface of the concrete in an acceptable manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface. Horizontal joints in walls and columns shall be maintained level. Concrete shall be placed in layers not over 18 inches deep and each layer shall be compacted by mechanical internal vibrating equipment supplemented by hand spading, rodding and tamping as directed. Vibrators shall not be inserted into lower courses that have begun to set.

3.06 FINISHES

A. Exposed to Public View Concrete Surfaces:

1. For all exterior exposed to public view concrete surfaces, including the outside surfaces of tanks, form faces shall be smooth and forms shall be true-to-line and grade. Surfaces produced by forms shall require only minor dressing to arrive at true surfaces. Do not reuse forms with surface wear, tears, or defects that lessen the quality of the surface. Thoroughly clean and properly coat forms before reuse.

2. All formed exposed to view concrete surfaces shall have a "smooth rubbed finish". Exterior vertical surfaces shall be rubbed to one foot

below grade. Interior exposed to public view vertical surfaces of liquid containers shall be rubbed to one (1) foot below the minimum liquid level that will occur during normal operations.

B. All vertical surfaces in liquid containing structures shall have a "smooth form" finish.

1. All "smooth form" concrete vertical surfaces shall be a true plane within 1/4 inch in ten (10) feet as determined by a ten (10) foot straightedge placed anywhere on the surface in any direction. Abrupt irregularities shall not exceed 1/8 inch.

C. Basin, flume, conduit and tank floors shall have a "smooth troweled" finish unless shown otherwise on Drawings.

D. Weirs and overflow surfaces shall be given a hard "smooth troweled" finish.

E. Exterior platforms, steps and landings, shall be given a "broom" finish. "Broom" finish shall be applied to surfaces which have been steel-troweled to an even, smooth finish. The troweled surface shall then be broomed with a fiber-bristle brush in the direction transverse to that of the main traffic.

3.07 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Foundations: Provide foundations as shown on Drawings.

1. Unless otherwise directed by the Engineer, the vertical surfaces of footings shall be formed. Excavations and reinforcement for all footings shall have been inspected by the Engineer before any concrete is placed.

D. The installation of underground and embedded items shall be inspected before slabs are placed. Pipes and conduits shall be installed below the concrete unless otherwise indicated. Fill required to raise the subgrade shall be placed as specified in Section "Earthwork". Porous fill not less

than 6 inches in compacted thickness shall be installed under all slabs, tank bottoms, and foundations. The fill shall be leveled and uniformly compacted to a reasonably true and even surface. The surfaces shall be clean, free from frost, ice, mud and water. Waterproof paper, polyethylene sheeting of nominal 4-mil minimum thickness, or polyethylene-coated burlap shall be laid over all surfaces receiving concrete.

E. Concrete Walks and Curbs:

1. Subgrade shall be true and well compacted at the required grades. Spongy and otherwise unsuitable material shall have been removed and replaced with approved material. Concrete walks shall be placed upon porous fill covered with waterproof paper, polyethylene sheeting of nominal 4-mil minimum thickness or polyethylene-coated burlap.

2. Concrete walks shall be not less than 4 inches in thickness. Walks shall have contraction joints every 5 linear feet in each groove in the top surface of the slab to a depth of at least one-fourth the slab thickness with a jointing tool. Transverse expansion joints shall be installed at all returns, driveways, and opposite expansion joints in adjacent curbs. Where curbs are not adjacent, transverse expansion joints shall be installed at intervals of approximately forty (40) feet. Sidewalks shall receive a "broomed" finish. Scoring shall be in a transverse direction. Edges of the sidewalks and joints shall be edged with a tool having a radius not greater than 1/6 inch. Sidewalks adjacent to curbs shall have a slope of 1/4 inch per foot toward the curb. Sidewalks not adjacent to curbs shall have a slope of 1/4 inch per foot. The surface of the concrete shall show no variation in cross section in excess of 1/4 inch in 5 feet. Concrete walks shall be reinforced with 6 x 6-W1.4xW1.4 welded wire reinforcement.

3. Concrete curbs shall be constructed to the section indicated on the Standard Detail, and all horizontal and vertical curves shall be incorporated as indicated or required. Forms shall be steel as approved by the Engineer. At the option of the Contractor, the curbs may be precast or cast-in-place. Cast-in-place curbs shall be divided into sections 8 to 10 feet in length using steel divider plates. The divider plates shall extend completely through the concrete and shall be removed. Precast curbs shall be cast in lengths of 4 to 5 feet. All exposed surfaces of concrete shall be finished smooth. All sharp edges and the edges of joints and divisions shall be tooled to 1/4 inch radius. Steel reinforcement shall be installed where the curb crosses pipe trenches or other insecure foundations. Such reinforcement shall consist of two (2) No. 4 deformed bars near the

bottom of the curb and shall extend at least 24 inches beyond the insecure area. Transverse expansion joints shall be installed at all curb returns and at intervals of approximately 40 feet.

F. Column base plates, bearing plates for beams and similar structural members, machinery and equipment bases shall, after being plumbed and properly positioned, be provided with full bearing with nonshrink grout. Concrete surfaces shall be rough, clean, free of oil, grease, and laitance and shall be moistened thoroughly immediately before grout is placed. Metal surfaces shall be clean and free of oil, grease and rust. Mixing and placing shall be in conformance with the material manufacturer's printed instructions. After the grout has set, exposed surfaces shall be cut back one (1) inch and covered with a parge coat of mortar consisting of one (1) part Portland cement, two (2) parts sand and sufficient water to make the mixture placeable. Parge coat shall have a smooth dense finish. Exposed surfaces of grout and parge coat shall be water cured with wet burlap for seven (7) days.

G. Grout fill which is formed in place by using rotating equipment as a screen, such as clarifiers and similar types of equipment, shall be mixed in proportions and consistencies as required by the manufacturer or supplier of the equipment.

H. Unless otherwise shown or directed, all pumps, other equipment, and items such as lockers, motor control centers and the like, shall be installed on concrete bases. The bases shall be constructed to the dimensions shown on the plans or as required to meet plan elevations. Where no specific plan elevations are required, the bases shall be 6 inches thick and shall extend 3 inches outside the metal equipment base. In general, the concrete bases shall be placed up to 2 inches below the metal base. The equipment shall then be properly shimmied to grade and the 2- inch void filled with nonshrink grout.

I. Manhole or access steps shall be plastic, constructed of copolymer polypropylene meeting the requirements of ASTM D2146 for Type II, Grade 16906 material. Step shall be reinforced with ASTM A615, Grade 60, #4 deformed steel reinforcing bar, be 9" deep, 14" wide, provided with notched tread ridge, foot retainer lugs on each side of tread and penetration stops for press fit installation. Plastic steps shall be PS2-PF as manufactured by M.A. industries, Inc., Peachtree City, Georgia. Steps shall be installed by drilling 1" diameter holes, minimum 3-3/4 inches deep into the wall and then driving steps into hole to the penetration stop, resulting in a press fit condition.

J. All existing contact surfaces with new patch shall be coated with moisture insensitive epoxy bonding adhesive, Sikadur Hi-Mod, Concresive LPL

Liquid by BASF Construction Chemicals, or approved equal. Patch shall consist of base pour of 4,000 psi structural concrete, then a topping of non-shrink natural aggregate grout, Masterflow 713, Sonogrout by BASF Construction Chemicals, or approved equal, mixed and placed in accordance with manufacturer's instructions, to the thicknesses shown on Drawings. Coat base pour with epoxy bonding adhesive prior to placing grout course.

3.08 WATERTIGHTNESS TESTING

A. The structures which are intended to contain liquids and/or will be subjected to exterior hydrostatic pressures shall be so constructed that, when completed and tested, there shall be no loss of water and no wet spots shall show.

B. The structure shall not be tested before all elements of the structure which resist any portion of the retained liquid pressure are in place and the concrete has attained its specified compressive strength.

C. Unless otherwise specified, coating shall not be applied until after the hydrostatic tightness testing is complete. Liners that are mechanically locked to the surface during the placement of the concrete shall be installed before the hydrostatic tightness testing. Interior liners shall be visually examined for deficiencies and must pass integrity testing. Deficiencies shall be repaired.

D. The concrete surfaces and concrete joints shall be thoroughly inspected for potential leakage points. Areas of potential leakage hall be repaired before filling the containment structure with water.

E. 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. All structural penetrations and inlets/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. If the structure is to be filled using the inlet/outlet pipe, positive means shall be provided to check that water is not entering or leaving though this pipe once the structure is filled to the test level. Leakage at these inlet/outlets shall be repaired prior to testing. No allowance shall be made in the test measurements for uncorrected known points of leakage.

F. No backfill shall be placed against the walls or on the wall footings of the structure to be tested unless otherwise specified.

G. The groundwater 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.

H. As soon as practicable, after the completion of the structures, the Contractor shall fill them with water and if leakages develop or wet spots show, the Contractor shall empty such structures and correct the leakage in an approved manner. Any cracks which appear in the concrete shall be dug out and suitably repaired. Temporary bulkheads over pipe openings in walls shall be provided as required for the testing.

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

J. After repairs, if any are required, the structures shall be tested again and further repaired if necessary until satisfactory results are obtained. All work in connection with these tests and repairs shall be at the expense of the Contractor.

K. If any leaks, in excess of the specified amount, are not remedied by the Contractor within four 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 General Contractor.

L. Waterstops shall be placed in other locations as indicated on the Drawings and as required to assure the watertightness of all containers of liquids. Special shop fabricated ells, tees and crosses shall be provided at junctions. Waterstops shall be extended at least 6 inches beyond end of placement in order to provide splice length for subsequent placement. In slabs and tank bottoms, water stops shall be turned up to be made continuous with waterstops at bottom of walls or in walls.

M. Joints between pipe (except cast iron wall pipe) and cast-in-place concrete walls shall be sealed by means of a groove cast completely around the pipe; the groove shall be filled with a quick setting hydraulic compound similar and equal to Waterplug as made by BASF Construction Chemicals mixed and applied in accordance with the manufacturer's instructions.

3.09 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.

   b. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

3.10 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer’s written instructions.

   1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.11 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

   1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes

and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.03 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish blending with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of damaged or defective concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used subject to Engineer's approval.

3.12 FIELD QUALITY CONTROL - GENERAL

A. Inspection Agency: Owner will engage a qualified independent inspecting agency to inspect concrete construction and to review test reports prepared by Contractor’s independent testing agent.

END OF SECTION

SECTION 03410

PLANT-PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Precast structural concrete including hollow-core plank

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
4. Indicate separate face and backup mixture locations and thicknesses.
5. Indicate type, size, and length of welded connections by AWS standard symbols.
6. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
8. Include and locate openings larger than 10 inches. Where additional structural support is required, include header design.
9. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
10. Indicate relationship of precast structural concrete units to adjacent materials.

11. Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.
12. Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.
13. Indicate estimated camber for precast floor slabs with concrete toppings.
14. Indicate shim sizes and grouting sequence.
15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

C. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For producer.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as PCI-certified

B. Installer Qualifications: An experienced precast concrete erector who has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project installed by erector in Category S1 - Simple Structural Systems and who can produce an Erectors' Post Audit Declaration, according to PCI MNL 127, "PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products."

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with

PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."

E. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.6 COORDINATION

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Support units during shipment on non-staining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.

D. Lift and support units only at designated points indicated on Shop Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design precast structural concrete units.

B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.

C. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

D. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the following design loads within limits and under conditions indicated.

1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318.

2. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated

E. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

F. Welding Electrodes: Comply with AWS standards.

G. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.2 FABRICATION

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.

1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.

C. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.

D. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.

1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A 775/A 775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
3. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions **CHEMICAL FEED BUILDING**. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
4. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
1. Protect strand ends and anchorages with a minimum of 1-inch-thick, nonmetallic, non-shrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.

F. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

G. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.

H. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.

I. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

J. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.

K. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

L. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.3 FABRICATION TOLERANCES

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.4 COMMERCIAL FINISHES

A. Grade B Finish: Fill air pockets and holes larger than 1/4 inch in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch in width that occur more than once per 2 sq. in.. Grind smooth form offsets or fins larger than 1/8 inch. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.

B. Screed or float finish unformed surfaces NOT VISIBILE IN THE FINISHED STRUCTURE. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Owner may engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.

1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and

concrete mixtures as may be requested for additional testing and evaluation.

B. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.

1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Engineer.
2. Test cores in an air-dry condition or, if units are wet under service conditions, test cores after immersion in water in a wet condition.
3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
4. Report test results in writing on same day that tests are performed, with copies to Engineer, Contractor, and precast concrete fabricator. Test reports include the following:

    a. Project identification name and number.
    b. Date when tests were performed.
    c. Name of precast concrete fabricator.
    d. Name of concrete testing agency.
    e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

C. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

D. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Engineer's approval. Engineer reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting, cast-in-place concrete has attained minimum allowable design compressive strength and until supporting steel or other structure is structurally ready to receive loads from precast concrete units.

3.2 INSTALLATION

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.

1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
4. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.

1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units unless indicated otherwise.

F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.

1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
2. Clean weld-affected steel surfaces with chipping hammer followed by brushing and apply a minimum 4.0-mil-thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780/A 780M.
3. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and re-prime damaged painted surfaces.
4. Visually inspect welds and remove, reweld, or repair incomplete and defective welds.

G. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

1. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces.
2. Fill joints completely without seepage to other surfaces.
3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Place grout end cap or dam in voids at ends of hollow-core slabs.
5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Engineer.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Erection of precast structural concrete members.

B. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.

C. Testing agency will report test results promptly and in writing to Contractor and Engineer.

D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.5 REPAIRS

A. Repair precast structural concrete units if permitted by Engineer.

1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.

D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.

E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

3.6 CLEANING

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.

1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

SECTION 04220

LOAD-BEARING CONCRETE UNIT MASONRY

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Miscellaneous masonry accessories.

1.03 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops net-area compressive strengths at 28 days indicated on the drawings.

1.05 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C140 for compressive strength.

1.06 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Submit drawings including plans, elevations, and details showing sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Submit drawings including plans, elevations, and details of wall reinforcement. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315 and ACI SP-66.
3. Control Joint Layout: Locations of control joints on shop drawings. Follow locations indicated on contract drawings, but provide joints in accordance with NCMA TEK 10-2B and at a spacing not more than 24 feet apart.

C. Test Reports:

1. Concrete Masonry Unit Test: According to ASTM C140 for compressive strength.
2. Mortar Aggregate Ration Test (Proportion Specification): For each mix provided, according to ASTM C780.
3. Mortar Test (Proportion Specification): For each mix provided, according to ASTM C780. Test mortar for air content only, do not test compressive strength.
4. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

D. Certificates:

1. Masonry Units: Include data on material properties substantiating compliance with requirements.
2. Cementitious Materials: Include brand, type, and name of manufacturer.
3. Preblended, Dry Mortar Mixes: Include description of type and proportions of ingredients.
4. Grout Mixes: Include description of type and proportion of ingredients.
5. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
6. Reinforcing Bars
7. Testing Agency: Qualified according to ASTM C1093 for testing indicated.

8. Cold-Weather and Hot-Weather Procedures: Submit detailed description of methods, materials, and equipment to be used to comply with requirements.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.09 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.01 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.02 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units where indicated on drawings.

B. CMUs: ASTM C 90.

1. Density Classification: Lightweight.
2. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
3. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

C. Integral Water Repellent: Provide units made with integral water repellent for exposed units and for units in liquid containment areas.

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) ACM Chemistries, Inc.; RainBloc.
2) BASF Aktiengesellschaft; Rheopel Plus.
3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

2.03 MASONRY LINTELS

A. Masonry Lintels: Built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Temporarily support built-in-place lintels until cured. Masonry lintels to match pattern and texture indicated on drawings.

2.04 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

E. Aggregate for Grout: ASTM C 404.

F. Water-Repellent Admixture: (exterior CMU exposed to weather only) Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ACM Chemistries, Inc.; RainBloc for Mortar.
b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

G. Water: Potable.

2.05 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: 0.187-inch diameter.
4. Wire Size for Cross Rods: 0.148-inch diameter.
5. Wire Size for Veneer Ties: 0.187-inch diameter.

6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c..
7. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.

D. Masonry Joint Reinforcement for Multi-Wythe Masonry (CMU interior wythe with brick exterior wythe): Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.06 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.187-inch diameter, hot-dip galvanized steel wire.

C. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.187-inch- diameter, hot-dip galvanized steel wire.

D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153/A153M.

2.07 EMBEDDED FLASHING MATERIALS

A. See specification “Architectural (Veneer) Unit Masonry” for flashing information.

2.08 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

2.09 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime
4. For reinforced masonry, use portland cement-lime mortar.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For all concrete masonry use type M or S.

D. Pigmented Mortar: Use colored cement product.

1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi.
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.02 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.03 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet), or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.

4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.04 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.05 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. 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 deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.06 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.

3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.07 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.08 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.09 LINTELS

A. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.10 REINFORCEMENT UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL

A. Owner will engage a qualified inspecting agency to perform inspections and review tests performed by contractor’s independent testing agent.

B. Remove and replace work that does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION

SECTION 04230

VENEER MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Building (common) brick.
3. Mortar and grout.
4. Ties and anchors.
5. Cavity wall insulation.
6. Masonry Flashing

B. Related Sections:

1. Section “Load-Bearing Concrete Unit Masonry” for structural load-bearing masonry unit applications.

2. Section “Bituminous Damp Proofing” for damp proofing for backup walls.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each type and color of the following:

1. Face brick, in the form of straps of five or more bricks.
2. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
3. Weep holes and vents.
4. Accessories embedded in masonry veneer.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type and size of the following:

1. Masonry units.

    a. Include data on material properties.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Anchors, ties, and metal accessories.

B. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.5 QUALITY ASSURANCE

A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry veneer, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

C. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery

containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry veneer when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry veneer to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

C. Decorative CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
2. Density Classification: Normal weight.
3. Size (Width): As indicated
4. Pattern and Texture:

    a. Standard pattern, split-face finish.

5. Colors: As selected by Architect from manufacturer’s full range.

2.3 BRICK

A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

B. Face Brick: Facing brick complying with ASTM C 216.

1. Grade: SW.
2. Type: FBS.
3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 7500 psi.
4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.
7. Application: Use where brick is exposed unless otherwise indicated.
8. Color and Texture: As selected by Architect from manufacturer’s full range of color and texture options.

2.4 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91/C 91M.

1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
2. Pigments shall not exceed 10 percent of portland cement by weight.

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.

F. Water: Potable.

G. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with unit masonry containing integral water repellent from same manufacturer.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. BASF Corporation-Construction Systems.
    b. Grace Construction Products; W.R. Grace & Co. – Conn.

2.5 TIES AND ANCHORS

A. Masonry Joint Reinforcement for Multi-Wythe Masonry (CMU interior wythe with brick or CMU exterior wythe): Adjustable (two-piece) type, ladder design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches. See Specification Section “Load-bearing Concrete Unit Masonry” for more information.

2.6 EMBEDDED FLASHING MATERIALS

A. Flexible Flashing: Use the following unless otherwise indicated:

1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advanced Building Products Inc.; Copper Fabric Flashing.
        2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
        3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
        4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
        5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
        6) York Manufacturing, Inc.; Multi-Flash 500.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Weep/Vent Products: Use the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Building Products Inc.; Mortar Maze weep vent.
2) Blok-Lok Limited; Cell-Vent.
3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
4) Heckmann Building Products Inc.; No. 85 Cell Vent.
5) Hohmann & Barnard, Inc.; Quadro-Vent.
6) Wire-Bond; Cell Vent.

B. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advanced Building Products Inc.
b. Hohmann & Barnard, Inc.
c. Mortar Net USA, Ltd.

2. Configuration: Provide one of the following:

a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.

2.8 CAVITY-WALL INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, closed-cell product extruded with an integral skin.

B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.9 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry veneer without discoloring or damaging masonry veneer surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use masonry cement or mortar cement mortar unless otherwise indicated.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry Veneer: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry veneer below grade or in contact with earth, use Type S.
2. For exterior, above-grade, non-load-bearing walls; for interior non-load-bearing partitions; and for other non-load-bearing applications where another type is not indicated, use Type N.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry veneer construction to full thickness shown. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry veneer. After installing equipment, complete masonry veneer to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Select and arrange units for exposed unit masonry veneer to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

E. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet , 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.4 LAYING MASONRY VENEER

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 3.5 sq. ft. of wall area spaced not to exceed 32 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.

a. Where bed joints of wythes do not align, use adjustable (two-piece) type ties.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

C. Coat cavity face of backup wythe to comply with Section "Bituminous Dampproofing."

D. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing, concrete, and masonry backup with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
3. Embed tie sections connector sections and continuous wire in masonry joints. Provide air space between back of masonry veneer and face of sheathing as shown on drawings.
4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
5. Space anchors as indicated, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally with not less than 1 anchor for each 3.5 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry veneer as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control/expansion joints in brick and C.M.U. veneer as follows:

1. Build in compressible joint fillers where indicated.

2. Build in control/expansion joints at each joint in C.M.U. backup or but not less than 20 feet apart.

3.9 LINTELS

A. Install steel lintels where indicated.

B. Provide minimum bearing of 6 inches at each jamb unless otherwise indicated.

3.10 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry veneer at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, headers and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry veneer at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section "Joint Sealants" for application indicated.
5. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in "Joint Sealants" for application indicated.
6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.

C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry veneer.

D. Install weep holes in head joints in exterior wythes of first course of masonry veneer immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.11 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners,

openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
7. Clean stone trim to comply with stone supplier's written instructions.

3.12 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials including scrap are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION

SECTION 05006

ALUMINUM HANDRAIL

1.0 GENERAL

Provide all labor, materials, equipment and services required to furnish and install aluminum handrail in the locations shown on the Drawings.

2.0 QUALITY ASSURANCE

2.1 REQUIREMENTS OF REGULATORY AGENCIES

All railing shall meet the requirements of the applicable sections of the Occupational Safety and Health Administration (OSHA) and Kentucky Building Code 2018.

3.0 SUBMITTALS

3.1 SHOP DRAWINGS

A. Submit shop drawings for all railing, including anchorage methods, splices and attachments.

B. Identify location and type indicated.

C. Indicate railings in related and dimensional position with elevations and large scale details.

D. Control details and dimensions not covered by field conditions.

E. Indicate all required field dimensions.

3.2 MAINTENANCE INSTRUCTIONS

Provide from aluminum rail manufacturer, recommendations describing procedures for maintaining, including cleaning materials, application methods and precautions as to use of materials, which may be detrimental to finish when improperly applied.

3.3 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Submit manufacturer's assembly and installation instructions to the Engineer for review.

4.0 PRODUCT DELIVERY, STORAGE AND HANDLING

4.1 PACKING AND SHIPPING

Preassembled railings shall be packed in maximum rake (scissor) position to provide optimum in-transit protection. Railings shall be shipped assembled in 20-foot sections and shall be enveloped with extruded polyvinyl chloride (PVC) sleeves to provide surface protection during shipping, installation and general construction.

4.2 DELIVERY OF MATERIAL

A. Deliver, store and handle components in such a manner as to protect the finished surfaces from scratches, nicks, gouges, dents and other damage.

B. Leave protective covering intact on all material insofar as possible until material has been accepted by the Engineer.

4.3 STORAGE OF MATERIALS

A. Store components in dry, clean location, away from uncured concrete and masonry.

B. Cover with waterproof paper, tarpaulin or polyethylene sheeting.

4.4 HANDLING

Keep handling to a minimum.

4.5 PROTECTION

Maintain protective covering on railing until project is complete. Contractor shall protect the handrails from scratches, dents, etc. Damaged rails shall be replaced at the end of the project.

5.0 MATERIAL

ASTM B 429-73, Alloy 6105, Temper T5, 1-1/2 inch diameter, Sch. 40.

6.0 FITTINGS

Molded or cast aluminum, 514T alloy.

7.0 FINISHES

Extruded and cast components one hour 215-R1 clear anodize finish, 0.7 mil. Minimum film thickness.

8.0 PAINT

Aluminum in contact with concrete or dissimilar metals shall be coated with 2 coats of alkali resistant bituminous paint, Fed. Spec. TT-V-51F asphalt varnish or equal.

9.0 FASTENERS

All fasteners shall be AISI Type 316 stainless steel. One piece internally threaded tubular inserts which receive fasteners shall have minimum tensile strength of 85,000 psi.

10.0 DESIGN

10.1 One-piece, hollow post extrusions shall be spaced a maximum of 5'-0" o.c.

10.2 Rails shall be furnished in 20-foot lengths and attached to a minimum of four posts.

10.3 All rails shall have internal line-up members at joints to provide a continuous uniform surface of entire length.

10.4 All fasteners shall be tightened to sufficient torque to completely eliminate play at connections and attachments.

10.5 Fastener heads shall be covered with high impact aluminum caps to inhibit tampering.

11.0 INSTALLATION

11.1 The Contractor shall furnish and install railing where indicated on the Drawings, arranged in accordance with the manufacturer's recommendation, maintaining posts in plumb position and rails parallel.

11.2 All required templates, anchor bolts and recessed sleeves shall be supplied by railing manufacturer for insertion by Contractor.

11.3 All holes in structural steel to receive railing anchorage shall be provided by the fabricator according to locations prescribed by railing manufacturer.

12.0 WORKMANSHIP

12.1 Rail and post ends shall be cut accurately and square, and free of burrs, nicks or other irregularities.

12.2 All holes drilled to receive one-piece tubular inserts and stainless steel fasteners shall be proper size, tapped as required for positive connection, and countersunk.

12.3 Posts shall be plumb and rails parallel whether in horizontal or rake application.

13.0 CLEANING

13.1 Wash thoroughly using clean water and soap; rinse with clean water.

13.2 Do not use acid solution, steel wool or other harsh abrasive.

13.3 If stain remains after washing, remove finish and restore in accordance with recommendations.

14.0 REPAIR OF DEFECTIVE WORK

Remove stained or otherwise defective work and replace with material that meets specification requirements.

15.0 PAYMENT

No separate measurements or payment will be made for the aluminum handrails. Payment for this item shall be included in the work to which it is subsidiary in the Bid Schedule.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL FRAMING

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.

1.2 SUMMARY

A. Section Includes:

1. Structural steel framing.
2. Grout.

B. Section does NOT include:

1. Anchor bolts and miscellaneous metals, e.g. handrails, brick lintels, soffit framing, metal stairs, and other non-structural metal fabrications.

C. Provide all labor, materials, equipment and services required to furnish and install all structural steel framing as indicated on the Drawings and specified herein.

1.3 ACTION SUBMITTALS

A. The Contractor shall submit the following data for Engineer's review in accordance with Section 01340.

B. Product Data: For each type of product indicated.

C. Show fabrication of structural-steel components.

1. Submit drawings including plans, elevations, and details showing sizes, profiles, and locations of special shapes, and attachments to other work.
2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
3. Include embedment drawings.
4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
6. Fabrication drawings shall not be reproductions of Contract Drawings.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Fabricator shall have minimum 3 years of successful past performance of contracts for similar structures or shall be subject to approval by the Owner and Engineer based on successful past performance of contracts on similar structures.

B. Installer Qualifications: Installer shall have minimum 3 years of successful past performance of contracts for similar structures or shall be subject to approval by the Owner and Engineer based on successful past performance of contracts on similar structures.

C. Welding Procedure Qualifications: Must be in accordance with AWS D1.4/D1.4M.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303 “Code of Standard Practice for Steel Buildings and Bridges”.
2. AISC 360 “Specification for Structural Steel Buildings”.
3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Structural Steel Shapes shall conform to the ASTM specifications indicated on the drawings.

B. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-strength structural bolts, nuts and washers shall conform to the requirements indicated on the drawings.

2.3 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar
2. Surfaces to be field welded.
3. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection.

2.8 GALVANIZING

A. Galvanize steel where indicated on plans.

B. Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123 or ASTM A 153, as applicable.

C. Galvanize after fabrication where practicable. Do not substitute electrogalvanizing for material that is indicated to be hot-dipped galvanized.

D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC Paint 20.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner may engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

PART 3 - EXECUTION

3.1 FABRICATION

A. Structural material shall be fabricated and assembled in the shop to the greatest extent possible.

B. Shearing, flame cuttings, and chipping shall be done carefully and accurately. Sheared and flame cut edges shall be finished smooth by grinding, chipping, or planing.

C. The radii of reentrant flame cut fillets shall be not less than one inch and as much larger as practicable.

D. Sole plates of beams and girders shall have full contact with the flanges.

E. Where shown or required, stiffeners shall be fitted neatly between the flanges of beams and girders and, where tight fits are required to transmit bearing, the ends of stiffeners shall be milled or ground to secure an even bearing against the flanges or shall be grooved and fully buttwelded to the flanges. The corners of stiffener plates shall be cut to clear fillets of beams.

F. The clearance between the ends of spliced web plates shall not exceed ¼ inch.

G. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by the reaming operation.

H. Steel work to be encased in concrete, including surfaces of top flanges of members supporting concrete slabs shall, after fabrication, be cleaned of all oil or grease by solvent cleaners and, after erection, be cleaned of dirt and foreign material by thoroughly sweeping with a stiff fiber brush or other approved method.

3.2 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Templates shall be furnished, together with instructions for the setting of anchors, anchor bolts, and bearing plates. The Contractor shall ascertain that the items are properly set during the progress of the work.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.4 ERECTION

A. Prior to erection, members shall be identified by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded (or on surfaces of weathering steels that will be exposed in the completed structure). Do not locate match markings in areas that will decrease member strength or cause stress concentrations

B. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

C. Base Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

F. Splice members only where indicated.

G. Do not use thermal cutting during erection unless approved by Structural Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.5 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: As-indicated on drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

3.6 FIELD QUALITY CONTROL

A. Inspection Agency: Owner will engage a qualified independent and inspecting agency to inspect steel construction, high-strength bolt connections and welded connections and to review test reports prepared by Contractor’s independent testing agent.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents or with requirements.

3.7 REPAIRS AND PROTECTION

A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

B. Touchup Painting:

1. Cleaning and touchup painting are specified in Division 09 painting Sections.
2. Repair damaged galvanized coatings in accordance with ASTM A 780.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM FRAMING

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.

1.02 SUMMARY

A. Section Includes:

1. Structural aluminum framing.

2. Stainless steel fasteners for structural aluminum framing.

B. Provide all labor, materials, equipment and services required to furnish and install all structural aluminum framing as indicated on the Drawings and specified herein.

1.03 ACTION SUBMITTALS

A. The Contractor shall submit the following data for Engineer's review in accordance with Division 1 requirements.

B. Product Data: For each type of product indicated.

C. Shop Drawings of structural-aluminum components.

1. Submit drawings including plans, elevations, and details showing sizes, profiles, and locations of special shapes, and attachments to other work.

2. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

3. Include embedment drawings.

4. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

5. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

6. Fabrication drawings shall not be reproductions of Contract Drawings.

1.04 QUALITY ASSURANCE

A. Fabricator Qualifications: Fabricator shall have minimum 3 years of successful past performance of contracts for similar structures or shall be subject to approval by the Owner and Engineer based on successful past performance of contracts on similar structures.

B. Installer Qualifications: Installer shall have minimum 3 years of successful past performance of contracts for similar structures or shall be subject to approval by the Owner and Engineer based on successful past performance of contracts on similar structures.

C. Welding Procedure Qualifications: Must be in accordance with AWS D1.4/D1.4M.

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

E. Comply with applicable provisions of the following specifications and documents:

1. The Aluminum Association's "Aluminum Design Manual" (AA ADM 1-2015).

2. The American Institute of Steel Construction's "Code of Standard Practice for Steel Buildings and Bridges" (AISC 303).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep aluminum members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect aluminum members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

PART 2 - PRODUCTS

2.01 STRUCTURAL-ALUMINUM MATERIALS

A. Structural Aluminum Shapes shall conform to the ASTM specifications indicated on the drawings.

B. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. Structural bolts, and threaded rods shall be stainless steel conforming to ASTM A 193 Grade B8 Class 2.

B. Nuts shall be stainless steel conforming to ASTM A 194 Grade 8.

C. Flat washers shall conform to the dimensions of ANSI B18.2.1 and be of AISI Type 304 stainless steel. These are “USS Flat Washers” not “SAE Washers.”

D. Lock washers shall be split type conforming to the dimensions of ANSI B18.2.1 and be of AISI Type 304 stainless steel.

2.03 FABRICATION

A. Structural Aluminum: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AA ADM-2015.

1. Fabricate framing members with natural camber up.

2. Mark and match-mark materials for field assembly.

B. Bolt Holes: Cut or drill standard bolt holes perpendicular to metal surfaces.

C. Finishing: Accurately finish faces of members transmitting bearing loads.

D. Holes: Provide holes required for securing other work to structural aluminum and for other work to pass through aluminum framing members.

1. Cut or drill holes perpendicular to aluminum surfaces. Do not thermally cut aluminum framing members.

2.04 SHOP CONNECTIONS

A. Weld Connections: Comply with AWS D1.2/D1.2M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.05 SOURCE QUALITY CONTROL

A. Testing Agency: Owner may engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-aluminum work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

PART 3 - EXECUTION

3.01 FABRICATION

A. Structural material shall be fabricated and assembled in the shop to the greatest extent possible.

B. Cutting and drilling shall be done carefully and accurately. Cut edges shall be finished smooth by grinding or planing.

C. The radii of reentrant cut fillets shall be not less than one quarter inch and as much larger as practicable.

D. Sole plates of members shall have full contact with the members.

E. Where shown or required, stiffeners shall be fitted neatly between the flanges of beams and girders and, where tight fits are required to transmit bearing, the ends of stiffeners shall be milled or ground to secure an even bearing against the flanges or shall be grooved and fully welded to the flanges. The corners of stiffener plates shall be cut to clear fillets of beams.

F. Assembled pieces shall be taken apart, if necessary, for the removal of burrs and shavings produced by reaming operations.

3.02 EXAMINATION

A. Verify, with aluminum erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Templates shall be furnished, together with instructions for the setting of anchors, anchor bolts, and bearing plates. The Contractor shall ascertain that the items are properly set during the progress of the work.

B. Provide temporary shores, guys, braces, and other supports during erection to keep structural aluminum secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural aluminum, connections, and bracing are in place unless otherwise indicated.

3.04 ERECTION

A. Prior to erection, members shall be identified by an erection mark. Connecting parts assembled in the shop for reaming holes in field connections shall be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations

B. Set structural aluminum accurately in locations and to elevations indicated and within published tolerances.

C. Base Plates: Clean concrete- and masonry-bearing surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on protective pads and shims, or setting nuts as indicated.

2. Weld plate washers to top of baseplate where indicated on drawings.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate.

D. Maintain erection tolerances of structural aluminum within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

E. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

F. Splice members only where indicated.

G. Do not use thermal cutting during erection.

H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts, but only with Engineer's approval.

3.05 FIELD CONNECTIONS

A. All bolts and threaded rod anchors shall be installed with a nut, a split lock washer, and a USS Flat Washer.

B. Anti-seize compound shall be used on all threads to prevent galling of stainless steel.

3.06 FIELD QUALITY CONTROL

A. Owner will engage a qualified inspecting agency to perform inspections and review tests performed by contractor's independent testing agent.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents or with requirements.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SCOPE OF WORK

A. Provide all labor, materials, equipment and services for furnishing and installing the metal fabrications as shown on the Drawings and specified herein.

B. Metal fabrications include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere.

1.03 SUMMARY

A. This Section includes the following:

1. Miscellaneous Steel and Aluminum Framing Systems:

    a. Steel and aluminum framing and supports for mechanical and electrical equipment.
    b. Steel and aluminum framing and supports for applications where framing and supports are not specified in other Sections.
    c. Steel and aluminum framing for ladders, stairs, platforms, and walkways.
    d. Loose steel lintels for masonry veneer.

B. Related Sections:

1. Section: Cast-in-Place Concrete for installing anchor bolts, and other metal items cast into concrete.
2. Section: Aluminum Handrails and Railings.
3. Section: Aluminum Grating and Floor Plates.

1.04 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

B. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others. Provide detail drawings showing the dimensions of each piece including the dimensions and locations of all holes, openings, copes, etc. and the type and extent of the finishes for each piece.

1.05 QUALITY ASSURANCE

A. Pre-assemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code – Steel”.

C. Welding Qualifications: Qualify procedures and personnel according to the following, as applicable:

1. AWS D1.1/D1.1M, "Structural Welding Code – Steel”.
2. AWS D1.2/D1.2M, "Structural Welding Code – Aluminum”.
3. AWS D1.6, "Structural Welding Code - Stainless Steel.”

D. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for commercial class of stair unless more stringent requirements are indicated.

1.06 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.07 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.02 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500 Grade B, cold-formed steel tubing.

C. Steel Pipe: ASTM A 53/A 53M, Grade B standard weight (Schedule 40) unless otherwise indicated.

2.03 NON-FERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209/B 209M, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221/B 221M, Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

D. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

E. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

2.04 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, otherwise. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Eyebolts: ASTM A 489.

E. Machine Screws: ASME B18.6.3.

F. Lag Screws: ASME B18.2.1.

G. Wood Screws: Flat head, ASME B18.6.1.

H. Plain Washers: Round, ASME B18.22.1.

I. Lock Washers: Helical, spring type, ASME B18.21.

J. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

K. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

L. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.05 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Grout: Non-Shrink Non-Metallic Grout, Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CE CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this Section.

C. Paint:

1. Shop Primer for Ferrous Metal: Manufacturer's or Fabricator's standard, fast-curing, lead-free, "universal" primer; selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated and for capability to provide a sound foundation for field-applied topcoats prolonged exposure; complying with performance requirements of FS TT-P-645.

2. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds in galvanized steel, complying with the Military Specifications MIL-P-21035 (Ships) or SSPC-Paint-20.

2.06 ROUGH HARDWARE

A. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division-6 sections.

B. Fabricate items to sizes, shapes and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

2.07 STAIR SAFETY NOSINGS

A. Step safety nosings shall be 4-inch wide, aluminum grit, crosshatched surface, complete with screws, nuts and wing anchors for anchoring to concrete, pre-drilled to admit anchor screws, Wooster WP4T Alumogrit as manufactured by Wooster Products Company, Wooster, Ohio; Style AXPF Nosing by SAFE-T-METAL Company; or equal. Nosings shall be furnished for all new interior concrete steps only.

2.08 ALUMINUM GRATING STAIR TREADS

A. Provide aluminum grating for stair treads where metal stairs are shown on Drawings. Refer to Section “Aluminum Grating”.

2.09 LOOSE STEEL LINTELS

A. Provide loose structural steel lintels for openings and recesses in masonry walls and partitions as shown on Drawings. Weld adjoining members together to form a single unit where indicated. Provide not less than 6" bearing at each side of openings, unless otherwise indicated. Loose still lintels exposed to the weather shall be hot-dipped galvanized.

2.010 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide miscellaneous steel framing and supports, which are not a part of structural steel framework, as required to complete work.

B. Fabricate miscellaneous units to sizes, shapes and profiles indicated or, if not indicated, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise indicated, fabricate from structural steel shapes and plates and steel bars of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.

C. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Except as otherwise indicated, space anchors 24" O.C. and provide minimum anchor units of 1-1/4" x 1/4" x 8" steel straps.

PART 3 - EXECUTION

3.01 PREPARATION

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.02 INSTALLATION

A. General Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including, threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.

B. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in form work for items which are to be built into concrete masonry or similar construction.

C. Fit exposed connections accurately together to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units, which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

E. Bar Gratings: Comply with recommendations of NAAMM Metal Bar Grating Manual for installation of gratings, including installation clearances and standard anchoring details. Secure removable units to supporting members with type and size clips and fasteners indicated, or if not indicated as recommended by grating manufacturer for type of installation conditions shown. Secure non-removable units to supporting members by welding where both materials are the same; otherwise fasten by bolting as indicated above. Attach toe plates to gratings by welding, at locations indicated.

3.03 ADJUSTING AND CLEANING

A. Cleaning and touch-up painting of field welds, bolted connections and abraded areas of the shop paint on miscellaneous metal is specified in Division 9 of these Specifications.

B. For galvanized surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A780.

3.04 FIELD QUALITY CONTROL

A. Owner will engage a qualified inspecting agency to perform inspections and review tests performed by contractor’s independent testing agent.

B. Field and shop welds will be subject to testing and inspecting.

C. Remove and replace work where test results indicate that it does not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

END OF SECTION

SECTION 05530

ALUMINUM GRATINGS AND FLOOR PLATES

PART 1 – GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Aluminum rectangular bar gratings.

2. Aluminum rectangular bar stair treads with abrasive nosings.

1.02 QUALITY ASSURANCE

A. Fabricator shall be experienced in producing gratings similar to that indicated for this Project with a record of successful in-service performance and with sufficient production capacity to produce required units without delaying the Work.

B. Comply with applicable provisions of AWS D1.2 “Structural Welding Code—Aluminum.”

C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.03 SUBMITTALS

A. In addition to those submittals identified in the General Provisions, the following items shall also be submitted:

1. Product data for formed metal bar grating, manufacturer's clips and anchorage devices for gratings, and paint products.

2. Shop drawings detailing fabrication and erection of gratings. Include plans, sections, and details of connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

1.04 PROJECT CONDITIONS

Check actual locations of walls and other construction to which gratings must fit by accurate field measurements before fabrication; show recorded

measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. McNichols Co.
2. IKG Borden
3. Ohio Gratings, Inc.
4. Or equal

2.02 ALUMINUM CONSTRUCTION

A. Extruded bars and shapes shall meet ASTM B221 (ASTM B221M), alloys as follows:

1. 6061-T6 or 6063-T6 for bearing bars of gratings and shapes.
2. 6061-T1 or 6063-T5 for grating cross bars.

2.03 FASTENERS

Provide fasteners of aluminum or non-magnetic stainless steel.

2.04 FABRICATION

A. Form from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support.

1. Shear and punch metals cleanly and accurately.
2. Remove sharp or rough areas on exposed traffic surfaces.
3. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.

B. Comply with AWS recommendations and the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

C. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.

D. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

2.05 ALUMINUM BAR GRATING AND STAIR TREADS

A. Produce aluminum bar gratings of description indicated per NAAMM marking system that comply with the following:

1. Metal Bar Grating Standard: “Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads” published in ANSI/NAAMM MBG 531 “Metal Bar Grating Manual.”

B. Fabricate swage-locked rectangular bar aluminum gratings to comply with requirements indicated below:

1. Swage-locked grating with 3/16-inch or 1/4-inch thick bearing bars 1-3/16 inches o.c. and cross bars 4 inches o.c.

2. Bearing bar depth shall be as indicated on the Contract Drawings.

C. Fabricate aluminum grating treads with integral corrugated nosing and with plate carrier at each end for stringer connections. Secure treads to stringer with bolts.

D. Traffic surface for aluminum bar gratings shall be serrated; abrasive nosing for stair treads.

E. Aluminum finish for bar gratings and stair treads shall be mill.

F. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated, or if not indicated, as recommended by manufacturer, for attachment to supports.

1. Provide not less than four stainless steel saddle clips for each section of aluminum grating.

2. Furnish threaded stainless steel bolts with nuts and washers for each clip required.

G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

1. Edge band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

2. Do not notch bearing bars at supports to maintain elevation.

2.06 GRATING FRAMES AND SUPPORTS

A. Provide frames and supports, where indicated.

B. Fabricate units to sizes, shapes, and profiles indicated and required to receive gratings. Fabricate from shapes, plates, and bars of welded construction. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware, and similar items.

C. Equip frame with integrally welded anchors for casting into concrete or building into masonry.

1. Unless otherwise indicated, space anchors 18 inches o.c. and provide minimum anchor units in the form of aluminum straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long, with right angle bend at end.

2.07 FINISHES

A. Comply with NAAMM “Metal Finishes Manual” for recommendations relative to application and designations of finishes.

B. Finish gratings, frames, and supports after assembly.

PART 3 – EXECUTION

3.01 PREPARATION

Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.02 INSTALLATION, GENERAL

A. Provide anchorage devices and fasteners where necessary for securing to in-place construction. Include expansion anchors for concrete and masonry, through-bolts, and other connectors as required.

B. Perform cutting, drilling, and fitting required for installation. Set accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

E. Field welding shall comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

F. Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.03 INSTALLING RECTANGULAR BAR GRATINGS

A. Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Secure removable units to supporting members with type and size of clips and fasteners indicated, or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown. Units not labeled as removable are deemed to be fixed.

C. Secure fixed units to supporting members by welding where both materials are the same; otherwise, anchor each section of grating with 2 stainless steel saddle clips each end.

END OF SECTION

SECTION 07110

BITUMINOUS DAMPPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes bituminous dampproofing with protective covering, where applicable.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with National Roofing Contractors Association (NRCA) - Waterproofing Manual. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperatures above 40 degrees F for 24 hours before application and continuously until dampproofing has cured.

PART 2 PRODUCTS

2.1 BITUMINOUS DAMPPROOFING

A. Manufacturers:
   1. Euclid Chemical Co. – Dehydratine 75
   2. Karnak Corp. – No. 100 Non-Fibered Emulsion
   3. W.R. Meadows – SealMastic Emulsion

2.2 COMPONENTS

A. Hot Asphaltic Materials:
   1. Asphalt: ASTM D449, Type I. II. III.
   2. Asphalt Primer: ASTM D41, compatible with substrate.
   3. Asphaltic Sealing Mastic: ASTM D4586 Type I II.

****** OR ******

B. Coal Tar Materials:
   1. Coal Tar: ASTM D450, Type I. II.

2. Coal Tar Primer: ASTM D43, coal tar type.
3. Coal Tar Sealing Mastic: ASTM D5643 bitumen filled with mineral dust and mineral fibers, to mastic consistency, without asbestos.

****** OR ******

C. Cold Asphaltic Materials:
1. Asphalt Emulsion: Conforming to ASTM D3747.

2.3 ACCESSORIES

A. Protection Board: 1/8 inch thick bitumen impregnated glass fiberboard with integral drainage channels.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify surfaces are solid, free of matter detrimental to adhesion of dampproofing.

3.2 PREPARATION

A. Do not apply dampproofing to damp, frozen, dirty, dusty, or deck surfaces.

3.3 APPLICATION

A. Install bituminous dampproofing on all concrete or CMU walls located below grade with an interior occupied space. DO NOT use on water holding structures.

B. Apply Work in accordance with NRCA - Waterproofing Manual.

C. Prime surfaces and permit to dry.

D. Apply two coatings of dampproofing material by spray application.

E. Apply from 6 inches below finish grade elevation to top of footings.

F. Seal protrusions to and penetrations through dampproofing with mastic and flexible flashings. Seal watertight.

G. Protect finished dampproofing from damage during backfill operations by adhering protection board with mastic over treated surfaces.

H. Scribe boards around penetrations and projections.

END OF SECTION

SECTION 07214

FOAMED-IN-PLACE MASONRY WALL INSULATION

PART 1 - GENERAL

1.02 SUMMARY

A. Exterior masonry walls shall be insulated as specified herein.

B. Applications of insulation specified in this section include the following:

1. Foamed-In-Place masonry insulation for thermal, sound and fire resistance values.

1.03 SUBMITTALS

A. Product and technical presentation as provided by the manufacturer.

B. Certified Test Reports: With product data, submit copies of certified test reports showing compliance with specified performance values, including R-values, fire performance and sound abatement characteristics.

C. Material Safety Data Sheet: Submit Material Safety Data Sheet complying with OSHA Hazard Communication Standard, 29 CRF 1910 1200.

1.04 QUALITY ASSURANCE

A. Manufacturing Standards: Provide insulation produced by a single and approved manufacturer. The product must come from the manufacturer pre-mixed to ensure consistency.

B. Installer Qualifications for Foamed-In-Place Masonry Insulation: Engage an experienced dealer/applicator who has been trained and licensed by the product manufacturer and which has not less than three years direct experience in the installation of the product used.

C. Warranty: A one year product and installation warranty shall be issued by both the manufacturer and installer.

D. Fire Performance Characteristics: Provide insulation materials which are identical to those whose fire performance characteristics, as listed for each material or assembly of which insulation is a part, have been determined by testing, per methods indicated below, by a testing agency

acceptable to authorities having jurisdiction. Product must be classified by Underwriters Laboratory (“UL”) as to Surface Burning Characteristics

Surface Burning Characteristics: ASTM E-84

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers of Foamed-In-Place Masonry Insulation: Subject to compliance with product requirements. Manuafacturers must have a minimum of 5 years experience with producing CMU insulating products.

2.02 INSULATING MATERIALS

A. General: Provide insulating materials which comply with requirements indicated for materials, compliance with referenced standards, and other characteristics.

B. Foamed-In-Place Masonry Insulation: Two component thermal insulation produced by combining a plastic resin and catalyst foaming agent surfactant which, when properly ratioed and mixed, together with compressed air produce a cold-setting foam insulation in the hollow cores of hollow unit masonry walls.

1. Surface Burning Characteristics: Maximum flame spread, smoke developed and fuel contributed of 0, 5 and 0 respectively.

2. Combustion Characteristics: Must be noncombustible, Class A building material.

3. Thermal Values: "R" Value of 4.91/inch @ 32 degrees F mean; ASTM C-177.

4. Sound Abatement: Minimum Sound Transmission Class ("STC") rating of 53 and a minimum Outdoor Indoor Transmission Class ("OITC") rating of 44 for 8" wall assembly (ASTM E 90-90).

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

A. Application Assemblies:

Block Walls: 6", 8", 10" or 12" concrete masonry units
Cavity Walls: 2" cavity or greater

3.05 INSTALLATION OF FOAMED-IN-PLACE INSULATION

A. General: Install foamed-in-place insulation from interior, or as specified, prior to installation of interior finish work and after all masonry and structural concrete work is in place; comply with manufacturer's instructions.

B. Installation: Fill all open cells and voids in all hollow concrete masonry walls. The foam insulation shall be pressure injected through a series of 5/8" to 7/8" holes drilled into every vertical column of block cells (every 8" on center) beginning at an approximate height of four (4) feet from finished floor level. Repeat this procedure at an approximate height of ten (10) feet above the first horizontal row of holes (or as needed) until the void is completely filled. Patch holes with mortar and score to resemble existing surface.

END OF SECTION

SECTION 07410

METAL ROOF PANELS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Exposed fastener metal roof panels, with related metal trim and accessories.

1.2 REFERENCES

A. American Architectural Manufacturer's Association (AAMA):

1. AAMA 621 - Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) & Zinc-Aluminum Coated Steel Substrates.
2. AAMA 809.2 - Voluntary Specification Non-Drying Sealants.

B. ASTM International (ASTM):

1. ASTM A 755 - Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
2. ASTM A 792/A 792M - Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
3. ASTM C 920 - Specification for Elastomeric Joint Sealants.
4. ASTM D 2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
5. ASTM D 4214 - Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Prior to erection of framing, conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's technical representative, inspection agency and related trade contractors.

1. Coordinate building framing in relation to metal panel system.
2. Coordinate openings and penetrations of metal panel system.

1.4 QUALITY ASSURANCE

A. Manufacturer/Source: Provide metal panel assembly and accessories from a single manufacturer providing fixed-base roll forming, and accredited under IAS AC 472 Part B.

B. Manufacturer Qualifications: Approved manufacturer listed in this Section with minimum five years experience in manufacture of similar products in successful use in similar applications.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

a. Product data, including certified independent test data indicating compliance with requirements.
b. Project references: Minimum of five installations not less than five years old, with Owner and Architect contact information.
c. Sample warranty.

C. Installer Qualifications: Experienced Installer with minimum of five years experience with successfully completed projects of a similar nature and scope.

1. Installer's Field Supervisor: Experienced mechanic, able to communicate with Owner, Architect, and installers, supervising work on site whenever work is underway.

1.5 ACTION SUBMITTALS

A. Product Data: Manufacturer’s data sheets for specified products.

B. Shop Drawings: Show layouts of metal panels. Include details of each condition of installation, panel profiles, and attachment to building. Provide details at a minimum scale 1-1/2-inch per foot of edge conditions, joints, fastener and sealant placement, flashings, openings, penetrations, and special details. Make distinctions between factory and field assembled work.

1. Indicate points of supporting structure that must coordinate with metal panel system installation.
2. Include data indicating compliance with performance requirements.
3. Include structural data indicating compliance with requirements of authorities having jurisdiction.

C. Samples for Initial Selection: For each exposed product specified including sealants. Provide representative color charts of manufacturer's full range of colors.

D. Samples for Verification: Provide 12 inch long section of each metal panel profile. Provide color chip verifying color selection.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Indicating compliance of products with requirements, witnessed by a professional engineer.

B. Qualification Information: For Installer firm and Installer's field supervisor.

C. Manufacturer's Warranty: Sample copy of manufacturer's standard warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance data.

B. Manufacturer's Warranty: Executed copy of manufacturer's standard warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect products of metal panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage. Protect panels and trim bundles during shipping.

1. Deliver, unload, store, and erect metal panel system and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.
2. Store in accordance with Manufacturer's written instructions. Provide wood collars for stacking and handling in the field.

1.9 WARRANTY

A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal panel assemblies that fail in materials and workmanship within one year from date of Substantial Completion.

1. **Fluoropolymer Two- Coat System**:

a. Color fading in excess of 5 Hunter units per ASTM D 2244.
b. Chalking in excess of No. 8 rating per ASTM D 4214.
c. Failure of adhesion, peeling, checking, or cracking.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis of Design Manufacturer: **MBCI Metal Roof and Wall Systems, Division of NCI Group, Inc.**; Houston TX. Tel: (877)713-6224; Web: www.mbci.com.

1. Provide basis of design product or comparable product approved by Engineer/Architect.

B. General: Provide metal roof panel system meeting performance requirements as determined by application of specified tests by a qualified testing facility on manufacturer's standard assemblies.

C. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction. Allow for deflection and design for thermal stresses caused by temperature differences from one side of the panel to the other.

D. Structural Performance: Provide metal panel assemblies capable of withstanding the effects of indicated loads and stresses within limits and under conditions indicated

E. **Air Infiltration**: ASTM E 283: Maximum 0.067 cfm/sq. ft. at 1.57 lbf/sq. ft. static-air-pressure difference.

F. **Water Penetration**: ASTM E 331: No uncontrolled water penetration at a static pressure of 6.24 lbf/sq. ft..

2.2 METAL PANEL MATERIALS

A. **Aluminum-Zinc Alloy-Coated Steel Sheet**: ASTM A 792/A 792M, structural quality, Grade 50, Coating Class AZ50 prepainted by the coil-coating process per ASTM A 755/A 755M.

2.3 METAL WALL PANELS

A. **Tapered-Rib-Profile, Exposed Fastener Metal Panels**: Structural metal panel consisting of formed metal sheet with trapezoidal ribs, installed by lapping edges of adjacent panels.

1. Basis of Design: **MBCI, PBR Panel,** www.mbci.com/pbr.html.
2. Coverage Width: 36 inches.
3. Continuous Rib Spacing: 12 inches on center.
4. Rib Height: 3/4 inch.
5. Nominal Coated Thickness: 24 Gauge
6. Panel Surface: Smooth
7. Exterior Finish: Fluoropolymer two-coat system.
8. Color: As selected by Architect from manufacturer's standard colors.

B. General: Provide complete metal panel assembly incorporating base, corner, and opening trims and miscellaneous flashings in manufacturer's standard profiles. Provide required fasteners, closure strips, support plates, and sealants as indicated in manufacturer's written instructions.

C. Flashing and Trim: Match material, thickness, and finish of metal panel face sheet.

D. Panel Fasteners: Self-tapping screws and other acceptable fasteners recommended by metal panel manufacturer.

1. Exposed Fasteners: Long life fasteners with EPDM or neoprene gaskets, with heads matching color of metal panels by means of factory-applied coating.

E. Joint Sealers: Manufacturer's standard or recommended liquid and preformed sealers and tapes, and as follows:

1. Tape Sealers: Manufacturer's standard non-curing butyl tape, AAMA 809.2.

2.4 FABRICATION

A. General: Provide factory fabricated and finished metal panels and accessories meeting performance requirements, indicated profiles, and structural requirements.

B. Panel Lengths: Form panels in continuous lengths for full length of detailed runs, except where otherwise indicated on approved shop drawings.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's written instructions, approved shop drawings, and project drawings. Form from materials matching metal panel substrate and finish.

2.5 FINISHES

A. Finishes, General: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

B. **Fluoropolymer Two-Coat System**: 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF fluoropolymer color coat, AAMA 621.

1. Basis of Design: **MBCI, Signature 300**.

C. **Fluoropolymer Two-Coat Metallic System**: 0.2 – 0.3 mil primer with 0.7 - 0.8 mil 70 percent PVDF metallic fluoropolymer color coat, AAMA 621.

1. Basis of Design: **MBCI, Signature 300 Metallic.**

D. Interior Finish: 0.5 mil total dry film thickness consisting of primer coat and wash coat of manufacturer's standard light-colored acrylic or polyester backer finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine metal panel system substrate and supports with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal panel installation.

1. Inspect metal panel support substrate to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable supports at recommended spacing to match installation requirements of metal panels.
2. Panel Support Tolerances: Confirm that panel supports are within tolerances acceptable to metal panel system manufacturer but not greater than the following:

    a. 1/4 inch in 20 foot in any direction.

B. Correct out-of-tolerance work and other deficient conditions prior to proceeding with metal panel system installation.

3.2 PREPARATION

A. Miscellaneous Supports: Install subframing, girts, furring, and other miscellaneous panel support members according to ASTM C 754 and manufacturer's written instructions.

B. Flashings: Install flashings to as indicated and required for a complete installation.

3.3 METAL PANEL INSTALLATION

A. Exposed Fastener Metal Wall Panels: Install weathertight metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal panels in orientation, sizes, and locations indicated, free of waves, warps, buckles, fastening stresses, and distortions. Anchor panels and other components securely in place. Provide for thermal and structural movement.

B. Panel Sealants: Install manufacturer's recommended tape sealant at panel sidelaps and endlaps.

C. Panel Fastening: Attach panels to supports using screws, fasteners, and sealants recommended by manufacturer and indicated on approved shop drawings.

1. Fasten metal panels to supports at each location indicated on approved shop drawings, with spacing and fasteners recommended by manufacturer.
2. Provide weatherproof jacks for pipe and conduit penetrating metal panels of types recommended by manufacturer.
3. Dissimilar Materials: Where elements of metal panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

3.4 ACCESSORY INSTALLATION

A. General: Install metal panel trim, flashing, and accessories using recommended fasteners and joint sealers, with positive anchorage to building, and with weather tight mounting. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel assembly, including trim, copings, flashings, sealants, closure strips, and similar items.
2. Comply with details of assemblies utilized to establish compliance with performance requirements and manufacturer's written installation instructions.
3. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently weather resistant.

B. Joint Sealers: Install joint sealers where indicated and where required for weathertight performance of metal panel assemblies, in accordance with manufacturer's written instructions.

1. Prepare joints and apply sealants as required to make a weather-tight seal and in accordance with the manufacturer’s published installation instructions and recommendations.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage an independent inspecting agency acceptable to Engineer/Architect to perform inspections and to review test reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective films immediately in accordance with metal panel manufacturer's instructions. Clean finished surfaces as recommended by metal panel manufacturer.

B. Replace damaged panels and accessories that cannot be repaired to the satisfaction of the Architect.

END OF SECTION

SECTION 07510

BUILT-UP BITUMINOUS ROOFING

PART 1 – GENERAL

The section provides details on bituminous built-up roofing systems for installation on a hollow-core precast concrete deck.

1.01 SUMMARY

A. Furnish and install a bituminous built-up roofing system meeting the roofing manufacturer's requirements for the specified warranty, including:
   1. Preparation of roofing substrates.
   2. Wood nailers for roofing attachment.
   3. Insulation.
   4. Cover board.
   5. Asphalt impregnated glass fiber mat reinforced roofing ply(s).
   6. Modified Bitumen Capsheet.
   7. Flashings.
   8. Other roofing-related items specified or indicated on the drawings or otherwise necessary to provide a complete weatherproof roofing system.

B. Disposal of demolition debris and construction waste is the responsibility of Contractor. Perform disposal in manner complying with all applicable federal, state, and local regulations.

C. Comply with the published recommendations and installation instructions of the roofing products manufacturer.

1.02 RELATED SECTIONS

Section 03410: Plant-Precast Structural Concrete

1.03 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.

B. LTTR: Long Term Thermal Resistance, as defined by ASTM1289-13ei.

1.04 REFERENCE STANDARDS

A. Referenced Standards: These standards form part of this specification only to the extent they are referenced as specification requirements.
   1. ASTM C208 - Standard Specification for Cellulosic Fiber Insulating Board; latest revision.
   2. ASTM C209 - Standard Test Methods for Cellulosic Fiber Insulating Board; latest revision.
   3. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2008.

4. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; latest revision.
5. ASTM D1079 - Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials; latest revision.

1.05 SUBMITTALS

A. Product Data:
   1. Provide manufacturer's printed submittal package to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with primary roofing materials.
   2. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
   3. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.
B. Shop Drawings:
   1. The roof manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
   2. For tapered insulation, provide project-specific layout and dimensions for each board.
C. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.
D. Close-out Documents: Executed Manufacturer’s Warranty.

1.06 QUALITY ASSURANCE

A. Applicator Qualifications: Roofing installer shall have the following:
   1. Current Licensed Applicator status from product manufacturer.
   2. At least five years of experience in installing specified system.
B. Pre-Installation Meeting: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the listed warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work.
   2. Notify Engineer well in advance of meeting.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
B. Store materials clear of ground and moisture with weather protective covering.

C. Do not overload building structure with stored materials

D. Keep combustible materials away from ignition sources.

1.08 WARRANTY

A. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.

B. Warranty: 20 year Limited Warranty covering all roof aspects including the roof insulation, cap board, bituminous ply(s), modified bitumen capsheet, and roof accessories.

C. Limit of Liability: No Dollar Limit.

1. Examples of criteria include the repair of leaks in the roofing system caused by:
   a. Manufacturing defects in materials.
   b. Defective workmanship used to install these materials.
   c. Damage due to winds up to 55 mph.

2. Examples of criteria excluded from warranty action includes:
   a. Damage due to winds in excess of 55 mph.
   b. Damage due to hurricanes or tornadoes.
   c. Hail.
   d. Intentional damage.
   e. Unintentional damage due to normal rooftop inspections, maintenance, or service.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer as specified for roofing system: Firestone Building Products LLC, or approved equal.

B. Roofing systems manufactured by others may be acceptable provided the roofing system is completely equivalent in materials and warranty conditions.

C. Manufacturer of Insulation and Cover Boards: Same manufacturer as roof ply(s) and capsheet.

D. Manufacturer of Metal Roof Edging: Same manufacturer as roof ply(s).

1. Metal roof edging products by other manufacturers are not acceptable.
2. Field or shop fabricated metal roof edgings are not acceptable.

2.02 ROOFING SYSTEM DESCRIPTION

A. Roofing System: Three (3) ply Built Up Roof (BUR) with modified bituminous granule surfaced capsheet.

1. Thickness: As specified elsewhere.
2. Insulation, Ply(s), Capsheet, and Attachment: Mineral granule surfaced cap sheet and smooth base sheet, conventional hot asphalt mopping.

2. Slope: Provide slope of 1/4 inch per foot (2%) by means of tapered insulation. Follow all crown and slope lines as indicated on drawings.
3. Comply with applicable local building code requirements.

B. Cover Board: Gypsum-Based Cover Board:
1. Thickness: 0.50 inch
a. Attachment: Low rise foam adhesive.

C. Insulation:
1. Total System R Value: 25, minimum.
2. Maximum Board Thickness: 3 inches; use as many layers as necessary; stagger joints in adjacent layers.

ISO Insulation Thickness Inches	**Insulation R Value***
1.00	5.7
1.50	8.6
1.75	10.0
2.00	11.4
2.30	13.2
2.50	14.4
2.80	16.2
3.00	17.4
3.25	18.9
3.50	20.5
3.75	22.0
4.00	23.6

**Long Term Thermal Resistance (LTTR) values provide a 15-Year time weighted average in accordance with ASTM 1289-13.*

Total ISO Insulation Thickness, nominal	**Roof System R Value**
3.5 inches	20R
4.5 inches	25R
5.25 inches	30R
6.25 inches	35R

2.03 SBS MODIFIED BITUMEN MATERIALS

A. Cap Sheet: Granule surfaced SBS polymer-modified bitumen sheet, reinforced with a non-woven polyester mat enhanced with continuous glass fiber yarn in the machine direction. complying with ASTM D6164, Type II, Grade G, with the following additional characteristics:

1. Formulated for MB cold adhesive, hot asphalt or roofing torch application.
2. Reinforcing Fabric: 7.8 oz. per sq. yd., non-woven polyester mat with continuous fiberglass strands in machine direction.
3. Nominal Thickness: 0.160 inch (4.1 mm).
4. Post Consumer Recycled Content: 5 percent, nominal.
5. Sheet Width: 3.3 feet (1 m), nominal.
6. Granule Color: UltraWhite; Solar Reflectance Index (SRI) of 87.
7. Acceptable Product: SBS Premium by Firestone, or approved equal

2.04 BITUMENOUS PLY MATERIALS

A. Ply Sheet: Asphalt impregnated, glass fiber mat reinforced roofing ply sheet, complying with ASTM D2178, with the following additional characteristics:
   1. Formulated for conventional hot asphalt or Firestone SEBS Mopping Asphalt.
   2. Nominal Thickness: 35 mil
   3. Sheet Width: 39.25 inches, nominal.
   4. Net Dry Mass: 8.9 lb. /100 sq. ft.
   5. Bituminous Saturant (Asphalt) min.: 7.0 lb. /100 sq. ft.

Acceptable Product: Ply VI by Firestone, or approved equal

2.05 ROOF INSULATION AND COVER BOARDS

A. Polyisocyanurate Board Insulation: Closed cell polyisocyanurate foam with black glass reinforced mat laminated to faces, complying with ASTM C 1289 Type II Class 1, with the following additional characteristics:
   1. Thickness: As indicated elsewhere.
   2. Size: 48 inches by 96 inches, nominal.
   3. Exception: Insulation to be attached using adhesive or asphalt may be no larger than 48 inches by 48 inches, nominal.
   4. R-Value (LTTR): 1.0 inch Thickness: 5.7 R, minimum.
   5. Compressive Strength: 20 psi when tested in accordance with ASTM C 1289.
   6. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.
   7. Recycled Content: 19 percent post-consumer and 15 percent post-industrial, average.
   8. Acceptable Product: ISO 95+ polyiso board insulation by Firestone, or approved equal.

B. Gypsum-Based Cover Board: Non-combustible, water resistant gypsum core with a primed surface on embedded glass mat facers, complying with ASTM C1177/C1177M, and with the following additional characteristics:
   1. Size: 48 inches by 96 inches, nominal.
      a. Exception: Board to be attached using adhesive or asphalt may be no larger than 48 inches by 48 inches, nominal.
   2. Thickness: As indicated elsewhere.
   3. Surface Water Absorption: 2.5 g, maximum, when tested in accordance with ASTM C473.

4. Spanning Capability: Recommended by manufacturer for following minimum flute spans:
   a. 0.50 inch (12 mm) Thickness: 5 inches (127 mm), minimum.
5. Surface Burning Characteristics: Flame spread of 0, smoke developed of 0, when tested in accordance with ASTM E84.
6. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
7. UL Classified for use with UL "P" series roofing assemblies.
8. Factory Mutual approved for use with FM 1-60 and 1-90 rated roofing assemblies.
9. Mold Growth Resistance: Zero growth, when tested in accordance with ASTM D3273 for minimum of 4 weeks.

C. Low Rise Foam Adhesive: Two-component, low-rise polyurethane adhesive designed to attach polyisocyanurate insulation to a variety of acceptable substrates; ISO Stick by Firestone, or approved equal.

2.06 METAL ACCESSORIES

A. Metal Roof Edging and Fascia: Continuous metal edge member serving as termination of roof membrane and retainer for metal fascia; watertight with no exposed fasteners; mounted to roof edge nailer.
   1. Wind Performance:
      a. Membrane Pull-Off Resistance: 100 lbs/ft (1460 N/m), minimum, when tested in accordance with ANSI/SPRI ES-1 Test Method RE-1, current edition.
      b. Fascia Pull-Off Resistance: At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-2, current edition.
      c. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-270 rating.
   2. Description: Two-piece; 45 degree sloped galvanized steel sheet edge member securing top and bottom edges of formed metal fascia; Firestone EdgeGard, or approved equal.
   3. Fascia Face Height: As shown on drawings.
   4. Edge Member Height Above Nailer: 1-1/4 inches
   5. Length: 144 inches
   6. Functional Characteristics: Fascia retainer supports while allowing for free thermal cycling of fascia.
   7. Aluminum Bar: Continuous 6063-T6 alloy aluminum extrusion with pre-punched slotted holes; miters welded; injection molded EPDM splices to allow thermal expansion.
   8. Anchor Bar Cleat: 20 gage, 0.036 inch G90 coated commercial type galvanized steel with pre-punched holes.
   9. Curved Applications: Factory modified.
   10. Fasteners: Factory-provided corrosion resistant fasteners, with drivers; no exposed fasteners permitted.
   11. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, scuppers, and end caps; minimum

14 inch long legs on corner pieces.

12. Scuppers: Welded watertight.
13. Accessories: Provide matching brick wall cap, downspout, extenders, and other special fabrications as shown on the drawings.

B. Parapet Copings: Formed metal coping with galvanized steel anchor/support cleats for capping any parapet wall; watertight, maintenance free, without exposed fasteners; butt type joints with concealed splice plates; mechanically fastened as indicated; Firestone PTCF.
   1. Wind Performance:
      a. At least the minimum required when tested in accordance with ANSI/SPRI ES-1 Test Method RE-3, current edition.
      b. Provide product listed in current Factory Mutual Research Corporation Approval Guide with at least FM 1-90 rating.
   2. Description: Coping sections allowed to expand and contract freely while locked in place on anchor cleats by mechanical pressure from hardened stainless steel springs factory attached to anchor cleats; 8 inch (200 mm) wide splice plates with factory applied dual non-curing sealant strips capable of providing watertight seal.
   3. Material and Finish: 24 gage, 0.024 inch thick galvanized steel with Kynar 500 finish in manufacturer's standard color; matching concealed joint splice plates; factory-installed protective plastic film.
   4. Dimensions:
      a. Wall Width: As indicated on the drawings.
      b. Piece Length: Minimum 144 inches
      c. Curved Application: Factory fabricated in true radius.
   5. Anchor/Support Cleats: 20 gage, 0.036 inch thick pre-punched galvanized cleat with 12 inch wide stainless steel spring mechanically locked to cleat at 72 inches on center.
   6. Special Shaped Components: Provide factory-fabricated pieces necessary for complete installation, including miters, corners, intersections, curves, pier caps, and end caps; minimum 14 inch long legs on corner, intersection, and end pieces.
   7. Fasteners: Factory-furnished; electrolytically compatible; minimum pull out resistance of 240 pounds for actual substrate used; no exposed fasteners.

2.07 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
   2. Thickness: Same as thickness of roof insulation.

B. Cant Strips and Tapered Edge Strips: 45 degree face slope and minimum 5 inch face dimension; provide at all angle changes between vertical and horizontal planes that exceed 45 degrees.
   1. Type: fiberous, complying with ASTM C208.
   2. Install using low rise foam adhesive, hot asphalt (Type III or IV), roofing mastic, or mechanically fastened using fasteners and plates approved by roofing manufacturer.

PART 3 – EXECUTION

3.01 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.

E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F (15 to 25 degrees C).

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from bitumen, adhesives, sealants and coatings.
   2. Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.
   3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.

I. Consult membrane manufacturer's instructions, container labels, and Safety Data Sheets (SDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION

A. Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck.

B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.

C. Examine roof substrate to verify that it is properly sloped to drains.

D. Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.

3.03 PREPARATION

A. Take appropriate measures to ensure that fumes from solvents are not drawn into the building through air intakes.

B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.

C. Fill all surface voids in the immediate substrate that are greater than 1/4 inch (6 mm) wide with fill material acceptable insulation to membrane manufacturer.

D. Seal, grout, or tape deck joints, where needed, to prevent bitumen seepage into building.

E. Wood Nailers: Provide wood nailers at all perimeters and other locations where indicated on the drawings, of total height matching the total thickness of insulation being used.
   1. Install with 1/8 inch gap between each length and at each change of direction.

3.04 INSULATION AND COVER BOARD INSTALLATION

A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.

B. Install insulation in a manner that will not compromise the vapor retarder integrity.

C. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

D. Lay roof insulation in courses parallel to roof edges.

E. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch (6 mm). Fill gaps greater than 1/4 inch (6 mm) with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch (6 mm).

F. Adhesive Attachment: Apply in accordance with membrane manufacturer's instructions and recommendations; "walk-in" and weight down individual roof insulation boards to obtain maximum adhesive contact.

3.05 ASPHALT APPLICATION - GENERAL

A. Apply by machine or hand. Follow all industry and manufacturer requirements for heating, storage and handling of asphalt. Do not apply asphalt or ply sheets if temperature is above or below that recommended.

B. During installation of the roofing ply(s), keep mop full with proper amounts of asphalt; do not scrub with the mop when applying the asphalt. Asphalt in this application is used as an adhesive for the modified bitumen membrane and should be installed at approximately 400° F at the point of application at a rate of 20-25 lbs per 100 square feet.

C. Extend hot asphalt application not more than 5 to 10 feet beyond roll currently being installation and no more than 48 inches when the temperature is below 50 degrees F.

D. Keep roof top traffic to a minimum on newly applied membrane and for a period after in order to minimize damage and bitumen displacement. Set rolls from the “cold” side of the roof.

E. Roll the roofing membrane with positive pressure to assure firm and uniform attachment to the adjacent surface without creating any voids or wrinkles.

3.06 MODIFIED BITUMEN INSTALLATION WITH HOT ASPHALT

A. In air temperature below 50 degrees F, unroll sheets and allow to relax; flatten with broom if necessary to eliminate voids and obtain proper embedment.

B. Start at the low point with a full width sheet; embed sheets in full mopping of asphalt.

C. Maintain one-half sheet stagger between first and second layer; install with minimum 3 inch side laps and 6 inch end laps; keep sheets free of wrinkles, buckles and fish mouths.

D. Apply asphalt at rate recommended by roof membrane manufacturer; a minor flow of hot asphalt should be seen coming from the side laps.

E. Complete the entire membrane installation without undue delay.
   1. Exception: The cap sheet may be installed not more than 14 days after installation of the interply base sheet.
      a. Before resuming installation, be sure the surface of the last sheet is clean and dry; broomed and cleaned sufficiently using the necessary equipment.
      b. Remove materials that show evidence of water intrusion and replace with like material.
      c. Cover materials that have been damaged with additional layers of ply sheets installed over them equal in quantity to those originally installed.
      d. Prime the surface using asphalt primer at rate recommended by roofing manufacturer.

3.07 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow roofing manufacturer's instructions.
   2. Remove protective plastic surface film immediately before installation.
   3. Install water block sealant under the membrane anchorage leg.
   4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.
   5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.
   6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.
   7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.

C. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.

D. Roofing Expansion Joints: Install as shown on drawings and as recommended by roofing manufacturer.

E. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weathertight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing abuts to; extend flashing at least 8 inches high above ply surface.
   1. Use the longest practical flashing pieces.
   2. Evaluate the substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.
   3. Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.
   4. Provide termination directly to the vertical substrate as shown on roof drawings.

F. Roof Drains:
   1. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer's recommendations.
   2. Install formable flashing according to manufacturer’s details
   3. Position ply(s), then cut a hole for roof drain to allow 1/2 to 3/4 inch of ply to extend inside clamping ring past drain bolts.
   4. Make round holes in ply to align with clamping bolts; do not cut ply back to bolt holes.
   5. Apply sealant on top of drain bowl where clamping ring seats below the ply(s).
   6. Install roof drain clamping ring and clamping bolts; tighten clamping bolts to achieve constant compression.

G. Flashing at Penetrations: Flash all penetrations passing through the BUR; make flashing seals directly to the penetration.

H. Irregular Penetrations: Flash irregular penetrations with liquid flashing approved by the manufacturer.

3.08 FINISHING AND WALKWAY INSTALLATION

A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.
   1. Use like granular face membrane in a contrasting color as a walkway pad unless otherwise indicated.

B. Walkway Pads: Adhere to the roofing surface, spacing each pad or run at minimum of 1.0 inch and maximum of 3.0 inches from each other to allow for drainage.

C. Pavers: Install butted tightly, not more than 1/2 inch apart.
   1. Pavers for Walkways: Prior to setting pavers, adhere an additional layer of roofing ply over area where pavers will be laid, extending minimum of 2 inches beyond the paver.

3.09 FIELD QUALITY CONTROL

A. Inspection by Manufacturer: Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a sales person).

B. Perform all corrections necessary for issuance of warranty.

3.10 CLEANING

A. Clean all contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.

B. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.

C. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.11 PROTECTION

A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

1.0 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section. Contractor shall furnish a complete door system with all necessary equipment as indicated on the drawings and as specified under this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

2. Finish hardware.

B. Related Sections

1. Division 4 Section for embedding anchors for hollow metal work into concrete unit masonry construction.

2. Division 8 Section for door hardware for hollow metal doors.

3. Division 9 Sections for field painting hollow metal doors and frames.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions and finishes.

B. Shop Drawings: Include the following:
1. Elevations of each door design.

2. Details of doors, including vertical and horizontal edge details and metal thickness.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.

4. Locations of reinforcement and preparations for hardware.

5. Details of each different wall opening condition.

6. Details of anchorages, joints, field splices and connections.

7. Details of accessories.

8. Details of moldings, removable stops and glazing.

C. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver hollow metal work palletized, wrapped or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum ¼ inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors. Deliver such items to Project site in time for installation.

2.0 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with contract requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ceco Door Products; an Assa Abloy Group company.
2. Curries Company; an Assa Abloy Group company.
3. Security Metal Products Corp.; an Asa Abloy Group company.
4. Steelcraft; an Allegion company.

2.2 MATERIALS

A. Cold Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot Rolled Steel Sheet: ASTM A 1011-A 1011M, Commercial Steel (CS), Type B; free of scale, pitting or surface defects; pickled and oiled.

C. Metallic Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts and Fasteners: Hot dip galvanized according to ASTM A 153/A 153M.

F. Powder Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143.

H. Mineral Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6 to 12 lb./cu ft. density; with maximum flame spread and smoke development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Division 8 Section.

J. Bituminous Coating: Cold applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert type noncorrosive compound free of asbestos fibers, sulfur components and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.

1. Design: Flush panel.

2. Core Construction: Manufacturer's standard Kraft power honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral board or vertical steel stiffener core.

3. Vertical Edges for Single Acting Doors: Beveled edge.

   a. Beveled Edge: 1/8 inch in 2 inches.

4. Top and Bottom Edges: Closed with flush or inverted 0.042 inch thick (18 Gauge), end closures or channels of same material as face sheets.

5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames".

B. Exterior Doors: Face sheets fabricated from metallic coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 (SDI 100) for level and model and ANSI A250.4 for physical performance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

    a. Width: 1-¾ inches

C. Interior Doors: Face sheets fabricated from cold rolled steel sheet unless metallic coated sheet is indicated. Provide doors complying with requirements indicated below by referencing ANSI A250.8 (SDI 100) for level and model and ANSI/SDI A250.4 for physical performance level:

1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

    a. Width: 1-¾ inches

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold or hot rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI A250.8 (SDI 100) and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic coated steel sheet.

1. Fabricate frames with mitered or coped corners.

2. Fabricate frames as full profiled welded unless otherwise indicated.

3. Frames for Level 3 Steel Doors: 0.067 inch thick (14 Gauge) steel sheet.

C. Interior Frames: Fabricated from cold rolled steel sheet.

1. Fabricate frames with mitered or coped corners.

2. Fabricate frames as full profile welded unless otherwise indicated.

3. Fabricate knocked down, drywall slip-on frames for in place gypsum board partitions.

4. Frames for Level 3 Steel Doors: 0.067 inch thick (14 Gauge) steel sheet.

5. Frames for Borrowed Lights: 0.053 inch thick (16 Gauge) steel sheet.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforced plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap and stirrup or T shaped anchors to suit frame size, not less than 0.042 inch thick (18 Gauge), with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.04375 inches thick (19 Gauge).

3. Compression Type for Drywall Slip-On Frames: Adjustable compression anchors.

4. Post-installed Expansion Type for In Place Concrete or Masonry: Minimum 3/8 inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, not less than 0.067 inch thick (14 Gauge), and as follows:

1. Monolithic Concrete Slabs: Clip type anchors, with two holes to receive fasteners.

2. Separate Topping Concrete Slabs: Adjustable type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction and finish as specified for adjoining hollow metal work.

2.7 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.8 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum ¼ inch thick by 1 inch wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.9 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/NAAMM-HMMA 861.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

2. Glazed Lites: Factory cut openings in doors.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress and make smooth, flush and invisible.

2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

3. Provide countersunk, flat or oval head exposed screws and bolts for exposed fasteners unless otherwise indicated.

4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.

6. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1. Two anchors per jamb up to 60 inches high.

2. Three anchors per jamb from 60 to 90 inches high.

3. Four anchors per jamb from 90 to 120 inches high.

4. Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

    b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1. Three anchors per jamb up to 60 inches high.

2. Four anchors per jamb from 60 to 90 inches high.

3. Five anchors per jamb from 90 to 96 inches high.

4. Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.

5. Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

    c. Compression Type: Not less than two anchors in each jamb.

    d. Post-installed Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

7. Door Silencers: Except on weather stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels and hardware reinforcement from either cold or hot rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section “Finish Hardware”.

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.

2. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with buttered or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.

2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

4. Provide loose stops and moldings on inside of hollow metal work.

5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.10 STEEL FINISHES

A. Prime Finish: Apply manufacturer’s standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer’s standard, fast curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria;

recommended by primer manufacturer for substrate; compatible with substrate and field applied coatings despite prolonged exposure.

3.0 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing in for embedded and built in anchors to verify actual locations before frame installation.

C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling and dressing, as required to make repaired area smooth, flush and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square-ness, alignment, twist and plumb-ness to the following tolerances:

1. Square-ness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

4. Plumb-ness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated, mortised and surface mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress and make splice smooth, flush and invisible on exposed faces.

    b. Install frames with removable glazing stops located on secure side of opening.

    c. Install door silencers in frames before grouting.

    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.

    e. Check plumb-ness, square-ness and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

    f. Field apply bituminous coating to backs of frames that are filled with grout containing anti-freezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

    a. Floor anchors may be set with powder actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

3. Metal Stud Partitions: Solidly pack mineral fiber insulation behind frames.

4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.

6. In Place Concrete or Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors and fill and make smooth, flush and invisible on exposed faces.

7. In Place Gypsum Board Partitions: Secure frames in place with post-installed expansion anchors through floor anchors at each jamb. Countersink anchors and fill and make smooth, flush and invisible on exposed faces.

8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.

9. Installation Tolerances: Adjust hollow metal door frames for square-ness, alignment, twist and plumb to the following tolerances:

    a. Square-ness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines and perpendicular to plane of wall.

    d. Plumb-ness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non Fire Rated Standard Steel Doors:

    a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.

    b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.

    c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.

    d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum ¾ inch.

D. Glazing: Comply with installation requirements in Division 8 Section “Glazing” and with hollow metal manufacturer’s written instructions.

1. Secure stops with countersunk flat or oval head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2-inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air drying, rust inhibitive primer.

D. Metallic Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer’s written instructions.

END OF SECTION

SECTION 08225

FIBERGLASS REINFORCED PLASTIC (FRP) DOORS AND FRAMES

1.0 QUALITY ASSURANCE

In addition to other applicable standards and codes, construction procedures shall comply with the following recommendations or requirements:

1.1 Provide fire-rated door and frame assemblies that comply with NFPA 80 "Standard for Fire Doors and Windows", and have been tested, listed, and labeled in accordance with ASTM E 152 "Standard Methods of Fire Tests of Door with ASTM E 152 "Standard Methods of Fire Tests of Door Assemblies" by a nationally recognized independent testing and inspection agency acceptable to authorities having jurisdiction.

1.2 Reference Standards

a. ASTM D635 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

b. ASTM E84 Standard Test Method for a Surface Burning Characteristics of Building Materials

c. Laminate Properties
   i. ASTM D882 Tensile Strength
   ii. ASTM D790 Flexural Strength
   iii. ASTM D2583 Barcol Hardness
   iv. ASTM D256 Impact Resistance
   v. ASTM D792 Density/Specific Gravity of Laminate
   vi. ASTM D1761 Mechanical Fastener

d. Core Properties
   i. ASTM C177 Thermal Properties
   ii. ASTM D1622 Density/Specific Gravity
   iii. ASTM E84 Surface Burning Characteristics
   iv. WDMA TM-10 and TM-5 Firestop ASTM E152 U.L. 10(b)

1.3 Warranty of fiberglass doors and frames for a period of 25 years against failure due to corrosion. Additionally, warranty all fiberglass doors and frames on materials and workmanship for a period of 10 years, including warp, separation or delamination, and expansion of the core.

2.0 SUBMITTALS

2.1 Submit manufacturer's technical product data substantiating that products

comply with requirements.

2.2 Submit Shop Drawings for fabrication and installation of doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

2.3 Provide schedule of doors and frames using same reference numbers for details and openings as those on Contract Drawings.

2.4 Indicate coordinate of glazing frames and stops with glass and glazing requirements.

3.0 PRODUCTS

3.1 Fabricate door and frame units to be rigid, neat in appearance and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Replacement frames may require field assembly. Clearly identify work that cannot be permanently factory-assembled before shipment, to assure proper assembly at project site. Provide door and frame products as manufactured by Chem-Pruf Door Co., as reference standard, or equal by Overly Door.

3.2 FRP Doors

a. Doors shall be made of fiberglass reinforced plastic (FRP) using chemically proven resins resistant to contaminants typically found in the environment for which these specifications are written, be 1-3/4" thick and of flush construction, having no seals or cracks, with a maximum dimension tolerance of $\pm$ 1/32".

b. Door plates shall be 1/8" thick, molded in one continuous piece, with a 25 mil gelcoat of the color specified, integrally molded with at least two layers of 1.5 ounce per square foot fiberglass mat and one layer of 16 ounce per square yard unidirectional roving, yielding a plate weight of 0.97 lbs. per square foot at a ratio of 30/70 glass to resin.

c. The stile and rail shall be molded in one continuous piece to a U-shaped configuration and to the exact dimensions of the door, no miter joints.

d. Core material shall be 2 psf expanded polyurethane foam; completely fill all voids.

e. Internal Reinforcement shall adequately support required hardware.

f. Window openings shall be provided for at time of manufacture and shall be

completely sealed so that the interior of the door is not exposed to the environment. Fiberglass retainers which hold the glazing in place shall be resin transfer molded with a profile that drains away from glazing. The retainers must match the color, texture and finish of the door plates. Glass shall be furnished and installed by door and frame manufacturer.

3.3 Frames shall be fiberglass with a minimum 25 mil gelcoat and a minimum of two layers continuous strand fiberglass mat saturated with resin, the frame will be of one-piece construction with molded stop. Provide internal reinforcement within the structure to allow for mounting of specified hardware.

3.4 Finish and texture of door and frame shall be selected by Owner/Engineer, and shall be resin-rich gelcoat integrally molded into both the door and frame. Secondary painting to achieve color is not acceptable.

3.5 Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.

3.6 Prepare all doors and frames to receive mortised and concealed finish hardware in accordance with final Finish Hardware Schedule and templates provided by hardware supplier. Comply with applicable requirements of ANSI A115 series specifications for door and frame preparation for hardware.

3.7 Locate finish hardware as indicated on final shop drawings or, if not indicated, in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.

3.8 Supports and anchors shall be as recommended by manufacturer.

3.9 Inserts, Bolts, and Fasteners: Manufacturer's standard units, except use stainless steel items to be built into exterior walls, complying with ASTM standards for bolts. Unless otherwise indicated, provide countersunk flat Phillips heads for exposed screws and bolts.

3.10 Trim around glazed openings in doors shall not protrude from the door face more than 1/8".

4.0 EXECUTION

4.1 Product Handling

4.1.1 Deliver FRP work in cartons or crated to provide protection during transit and job storage. Inspect work upon delivery for damage. Minor damages may be repaired provided refinished items are equal in all respects to new work and acceptable to Architect; otherwise, remove and replace damaged items as directed.

4.1.2 Store doors and frames at building site under cover. Place units on minimum 4" high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide 1/4" spaces between stacked doors to promote air circulation.

4.2 Installation

4.2.1 Install standard doors, frames, and accessories in accordance with final shop drawings, manufacturer's data, and as herein specified.

4.2.2 Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. For new work, place frames prior to construction of enclosing walls and ceilings. For replacement of existing work, remove existing frames & doors, and install frame pieces in existing opening (or revised opening). After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

4.2.3 Locate minimum 3 wall anchors per jamb at hinge and strike levels, more if required by manufacturer.

4.2.4 Install fire-rated frames in accordance with NFPA Std. No. 80.

4.2.5 Fit doors accurately in frames, using finish hardware as scheduled, within clearances specified in SDI-100. Place fire-rated doors with clearances as specified in NFPA Standard No. 80.

4.2.6 Check and readjust operating finish hardware items, leaving doors and frames undamaged and in complete and proper operating condition.

END OF SECTION

SECTION 08310

ALUMINUM ACCESS HATCHES

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section of the specifications shall include the furnishing of all materials, equipment, and labor necessary for the complete installation of access doors in sizes and locations shown on the DRAWINGS and described in these Specifications.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data.

B. Shop Drawings shall include fabrication, assembly, foundation and installation drawings along with detailed specifications and data covering materials, parts and accessories used. Shop Drawings shall include recommendations for maintenance and cleaning methods and precautions for use of materials, which may be detrimental to finishes when improperly applied.

C. Warranty: Submit executed copy of manufacturer's standard warranty.

1.3 QUALITY ASSURANCE

A. Manufacturer: A minimum of 5 years experience manufacturing similar products.

B. Installer: A minimum of 2 years experience installing similar products.

C. Manufacturer's Quality System: Registered to ISO 9001:2008 Quality Standards including in-house engineering for product design activities.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original packaging. Store materials in a dry, protected, well-vented area. Inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

1.5 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's standard warranty. Materials shall be free of defects in material and workmanship for a period of twenty five

years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Access hatches shall be Type J-AL Access Door as manufactured by The BILCO Company, or approved equal.

2.2 ACCESS DOOR

A. Furnish and install where indicated on plans and as provided in the schedule below vault access door Type J-AL.

Location	Quantity	Width (Inches)	Length (Inches)	Door Style
Spring Water Pump Station	3	36	48	Single
High Service Meter Vault	1	36	48	Single
1.45 MG Clearwell	4	36	48	Single

Length denotes hinge side. The floor access door shall be single leaf and pre-assembled from the manufacturer.

B. Performance characteristics:

1. Cover: Shall be reinforced to support a minimum live load of 300 pounds per square foot (PSF) with a maximum deflection of 1/150th of the span.
2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
3. Operation of the cover shall not be affected by temperature.
4. Entire door, including all hardware components, shall be highly corrosion resistant.

C. Cover: Shall be 1/4” thick aluminum diamond pattern.

D. Frame: Channel frame shall be extruded aluminum with bend down anchor tabs around the perimeter.

E. Hinges: Shall be specifically designed for horizontal installation and shall be through bolted to covers with tamperproof Type 316 stainless steel lock bolts and shall be through bolted to the frame with Type 316 stainless steel bolts and locknuts.

F. Drain Coupling: Provide a 1-1/2” drain coupling located in the right front corner of the channel frame.

G. Lifting mechanisms: Manufacturer shall provide the required number and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the covers when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe fastened to a formed 1/4” gusset support plate.

H. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug.

I. Hardware:

1. Hinges: Heavy forged Type 316 stainless steel hinges, each having a minimum 1/4” diameter Type 316 stainless steel pin, shall be provided and shall pivot so the covers do not protrude into the channel frame.
2. Cover shall be equipped with a hold open arm which automatically locks each cover in the open position.
3. Cover shall be fitted with the required number and size of compression spring operators. Springs and spring tubes shall be Type 316 stainless steel.
4. A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of one cover.
5. Hardware: Shall be Type 316 stainless steel throughout.

J. Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install products in strict accordance with manufacturer’s instructions and approved submittals. Locate units level, plumb, and in proper alignment with adjacent work.

1. Test units for proper function and adjust until proper operation is achieved.

2. Repair finishes damaged during installation.
3. Restore finishes so no evidence remains of corrective work.

3.3 ADJUSTING AND CLEANING

A. Clean exposed surfaces using methods acceptable to the manufacturer which will not damage finish.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fixed and/or operable aluminum-framed windows for exterior locations.

1.3 DEFINITIONS

A. Performance class designations according to AAMA/WDMA/CSA 101/I.S.2/A440-05:

1. AW: Architectural.

B. Performance grade number according to AAMA/WDMA/CSA 101/I.S.2/A440-05:

1. Design pressure number in pounds force per square foot (pascals) used to determine the structural test pressure and water test pressure.

C. Structural Test Pressure: For uniform load structural test, is equivalent to 150 percent of the design pressure.

D. Minimum Test Size: Smallest size permitted for performance class (gateway test size) or as specified elsewhere in this section, whichever is more stringent. Products must be tested at minimum test size or at a size larger than minimum test size to comply with requirements for performance class. Downsized test reports will not be considered acceptable.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide aluminum windows capable of complying with performance requirements indicated, based on testing manufacturer's windows that are representative of those specified. Windows tested shall be similar in size, 100% to 150% of the proposed windows width and height.

B. Structural Performance: Provide aluminum windows capable of withstanding the effects of the following loads, based on testing units of the minimum test

size specified herein that pass AAMA/WDMA/CSA 101/I.S.2/A440-05, Uniform Load Structural and Uniform Load Deflection Tests:

1. Uniform Load Structural Test: 105 psf (positive and negative).

2. Uniform Load Deflection Test: 70 psf (positive and negative).

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions for each type of aluminum window indicated.

B. Shop Drawings: Include plans, elevations, sections, details, hardware, attachments to other work, operational clearances, installation details, and the following:

1. Mullion details, including reinforcement and stiffeners.
2. Joinery details.
3. Weather-stripping details.
4. Thermal-break details.
5. Glazing details.
6. Calking product and details

C. Samples for Initial Selection: For units with factory-applied color finishes.

1. Include similar samples of hardware and accessories involving color selection.

D. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Product Qualifications: In order to confirm that the proposed product(s) conform to the material and performance requirements contained in these specifications, the Engineer may request the following submittal information. Failure to comply with the request will cause the submittals to automatically be rejected.

1. Product Test Reports: Comprehensive test reports not more than four years old prepared by a qualified testing agency for each window type being used on the project. Test reports based on the use of downsized test units will not be accepted.

2. Product Details: Product details showing all frame and sash details, dimensions, thermal break construction, wall thicknesses and joinery. Details must accurately reflect all glazing and hardware options specified herein.

B. Product Requirements: For maximum performance, windows for this project must meet both the testing requirements as contained herein and the minimum material requirements specified. Windows that carry the applicable AAMA rating but do not meet the material thicknesses, depths, etc. shall not be acceptable for use on this project.

C. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

D. Source Limitations: Obtain aluminum windows through one source from a single manufacturer.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of aluminum windows and are based on the specific system indicated. Do not modify size and dimensional requirements.

F. Fenestration Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440-05, "Standard/Specification for Windows, Doors, and Unit Skylights" for definitions and minimum standards of performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.

1. Provide AAMA-certified aluminum windows.

G. Glazing Publications: Comply with published recommendations of glass manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated.

1.7 PROJECT CONDITIONS

A. Field Measurements: For retrofit installations, verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating aluminum windows without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within ten (10) year warranty period. Warranty shall not be prorated for time and cover 100% material and labor costs.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, or air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of metals or other materials beyond that which is normal.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: Ten (10) years from date of Substantial Completion.
b. Glazing: Ten (10) years from date of Substantial Completion.
c. Painted Metal Finishes:
1) Ten (10) years from date of Substantial Completion for AAMA 2604 High Performance Finishes.
2) Twenty (20) years from date of Substantial Completion for AAMA 2605 Superior Performance Finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by aluminum window manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi ultimate tensile strength, not less than 16,000-psi minimum yield strength, and not less than 0.080-inch thickness at any location for the main frame and sash members, except the frame sill which shall be a minimum of 0.125-inch.

B. Frame/Sash Depth: 4 ¼" minimum frame depth; 1 ¾" minimum sash depth.

C. Fasteners: Aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum window members, trim, hardware, anchors, and other components.

1. All fasteners must be concealed except where unavoidable for application of hardware.
2. For application of hardware, where required, use non-magnetic stainless steel phillips machine screws.

D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

E. Compression-Type Weather Stripping: Provide compressible weather stripping designed for permanently resilient sealing under bumper or wiper action and for complete concealment when aluminum window is closed.

1. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA/CSA 101/I.S.2/A440-05.

F. Sliding-Type Weather Stripping: Provide woven-pile weather stripping of wool, polypropylene, or nylon pile and resin-impregnated backing fabric. Comply with AAMA 701/702.

1. Weather Seals: Provide weather stripping with integral barrier fin or fins of semirigid, polypropylene sheet or polypropylene-coated material. Comply with AAMA 701/702.

G. Replaceable Weather Seals: Comply with AAMA 701/702.

H. Sealant: For sealants required within fabricated windows, provide window manufacturer's standard, permanently elastic, nonshrinking, and nonmigrating type recommended by sealant manufacturer for joint size and movement.

2.2 WINDOW

A. Window Type: Fixed and Sliding

B. AAMA/WDMA Performance Requirements: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440-05.

1. Performance Class and Grade: AW70.

C. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a minimum CRF of 57.

D. Thermal Transmittance: Provide aluminum windows with a whole-window, U-factor maximum indicated at 15-mph exterior wind velocity and winter condition temperatures when tested using pyrolitic Low-E glass according to AAMA 1503.

1. U-Factor: 0.56 Btu/sq. ft. x h x deg F or less.

E. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA/CSA 101/I.S.2/A440-05, Air Infiltration Test.

1. Maximum Rate: 0.3 cfm/sq. ft. (5 cu. m/h x sq. m) of area at an inward test pressure of 6.24 lbf/sq. ft.

F. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.2/NAFS, Water Resistance Test.

1. Test Pressure: 20 percent of positive design pressure, but not less than 12 lbf/sq. ft..

G. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.

H. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA/CSA 101/I.S.2/A440-05.

I. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA/CSA 101/I.S.2/A440-05 for operating window types indicated.

2.3 INSULATED (DUAL) GLAZING

A. Construction: All windows (except those receiving insulated panels) shall be factory glazed with hermetically sealed 1” insulating glass units with a dual seal of polyisobutylene and silicone and a desicant filled aluminum spacer. Insulated glass must be set into a continuous bed of silicone sealant and held in place with removable extruded aluminum snap-in beads. Wrap around (marine) glazing which requires the removal and disassembling of the sash for re-glazing will not be acceptable. Units must be IGCC certified for a CBA rating level. Interior glazing shall be wrap around (marine) glazed into a removable access panel. Access panels shall be hollow extruded sections with minimum wall thickness of 0.062 inches and shall be miter cut and assembled with stainless steel screws for ease of repair. Tamper resistant security fastenings shall be installed at the bottom of each panel to securely attach panels to sash. For safety purposes, access panels shall be encased within channels at the top and bottom to prevent the panel from falling out even if the security fastening is removed.

1. Exterior Glazing:
   a. Thickness: 1/8”
   b. Tint: Clear
   c. Type: Annealed Glass or Tempered Glass

2. Interior Glazing:
   a. Thickness: 1/8”
   b. Tint: Clear
   c. Type: Annealed Glass or Tempered Glass
   d. Coating: Pyrolitic Low-E (#3 Surface)

2.4 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock aluminum windows and sized to accommodate sash or ventilator weight and dimensions. Do not use aluminum in frictional contact with other metals.

B. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

C. Sliding Windows: Provide the following operating hardware:
   1. Removable Sash: Design windows whereby both sash operate for ventilation and are removable from inside for cleaning and maintenance, and provide with hardware to permit removal of sash from inside for cleaning. (Products of “XO” design with only one operable/removable sash will not be acceptable).

2.5 INSECT SCREENS

A. General: Design windows and hardware to accommodate screens in a tight-fitting, removable arrangement, with a minimum of exposed fasteners and latches. Locate screens on outside of window. Provide insect screens on all operable sash.

B. Aluminum Insect Screen Frames: Manufacturer's standard aluminum alloy complying with SMA 1004. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

   1. Extruded-Aluminum Tubular Framing Sections and Cross Braces: Not less than 0.050-inch (1.3-mm) wall thickness.
   2. Finish: Match aluminum window members.

2.6 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.

C. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed (products with exposed thermal barriers will not be acceptable), low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

   1. All exterior aluminum shall be separated from interior aluminum by a rigid, structural thermal barrier. For purposes of this specification, a structural thermal barrier is defined as a system that shall transfer shear during bending and, therefore, promote composite action between the exterior and interior extrusions.
   2. No thermal short circuits shall occur between the exterior and interior.

3. The thermal barrier shall consist of two glass reinforced polyamide nylon 6/6 struts mechanically crimped in raceways extruded in the exterior and interior extrusions.
4. Poured and debridged urethane thermal barriers shall not be permitted.

D. Weather Stripping: Provide full-perimeter weather stripping for each operable sash and ventilator.

E. Grill: At location indicated on the plans, provide grill matching the window's finish. Grill to be installed between the interior and exterior glazing.

F. Factory-Glazed Fabrication: Glaze aluminum windows in the factory where practical and possible for applications indicated. Comply with requirements of AAMA/WDMA/CSA 101/I.S.2/A440-05.

G. Glazing Stops: Provide snap-on glazing stops coordinated with Division 08 Section "Glazing" and glazing system indicated. Provide glazing stops to match sash and ventilator frames.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Exterior of Window:
1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify rough opening dimensions, levelness of sill plate, and operational clearances. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight window installation.

1. Masonry Surfaces: Visibly dry and free of excess mortar, sand, and other construction debris.

2. Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in opening and within 3 inches (76 mm) of opening.
3. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing windows, hardware, accessories, and other components.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and ventilators, screens, hardware, and accessories for a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

B. Manufacturer shall clean all glass and aluminum prior to shipment.

C. Protection of newly installed windows and/or final cleaning of glass and aluminum to remove any accumulations that may have occurred during the construction period is to be the responsibility of the General Contractor or Owner.

D. Comply with manufacturer’s written recommendations for final cleaning and maintenance.

END OF SECTION

SECTION 08710

FINISH HARDWARE

1.0 SUBMITTALS

1.1 Hardware Schedule is by Hardware Set Number. Refer to drawings for designation of hardware set number applicable to each opening.

1.2 Certain additional items of hardware and/or hardware accessories specified herein shall be furnished and installed, although accessories may not appear in Hardware Schedule.

1.3 A complete Hardware Schedule indicating type, number, location and finish shall be submitted to Engineer for approval with such samples as may be required for review. Opening numbers shall be same as used in contract documents. Schedule shall be prepared according to Door and Hardware Institute recommendations (schedule and sequence format) and shall include degree of door closer installation.

1.4 Supplier's Hardware Schedule will be reviewed for type, quality and finish, and for function (other than hand). Contractor shall be responsible for checking schedule for correct hand of locksets and for supplying quantity of items required by contract documents.

1.5 Contractor shall provide supplementary or revised hardware schedules if deemed necessary.

1.6 Do not ship or deliver hardware to job prior to review of Hardware Schedule by Engineer.

1.7 Hardware schedule shall be submitted in the following format; schedules submitted to Engineer for review not in this format will be rejected.

HARDWARE SET 1 JOB NO. _____
1 SGLE 90 DEG. DR #001 EXTERIOR FROM CORRIDOR 101 RHRB
KEY GROUP ____ 3'8" X 7'0" X 1 3/4" HMD X HMF NARROW LITE

ITEM NO.	QUANTITY & PRODUCT TYPE	MANUFACTURER'S NUMBER, SIZE FINISH, & PRODUCT INFORMATION
1.	3 EA HINGE	BB1199 NRP 4 ½ X 4 ½ ATMS US-26D
2.	1 EA CYL	1109 US-26D GGMK
3.	1 EA EXIT DEV	99NL US-26D X 3'8" X 7'0" HMD X HMF NARROWLITE RHRB

2.0 QUALITY ASSURANCE

2.1 Hardware Consultant: As a mandatory requirement, all hardware shall be furnished by an established builders firm who maintains and operates an office, display and stock in this area, and who is a regular authorized distributor of the lock he/she proposes to furnish. All hardware for the project shall be scheduled and furnished by or under the direct supervision of an Architectural Hardware Consultant that is a regular member in good standing, of the Door and Hardware Institute who is a full time employee of the supplier. All schedules submitted for approval and job use shall carry the signature of this consultant and D.H.I. certified seal of this consultant.

2.2 No consideration will be granted for any alleged misunderstanding of the material to be furnished or work to be done. It shall be fully understood that the tender of a proposal carries with it the agreement to all items and conditions referred to herein or indicated on plans, whether specifically mentioned herein or not.

2.3 It shall be the responsibility of the hardware supplier to provide the proper hardware for door function and to meet the proper and applicable building codes. All discrepancies shall be brought to the attention of the Engineer a minimum of ten (10) days prior to bid date so an addendum may be issued. No additional compensation will be allowed after bidding for hardware changes required to meet the proper door function or to meet the proper codes.

2.4 Applicator: Finish hardware shall be installed by the carpentry contractor using tradesmen skilled in this type of work. Installation shall be in a neat workmanlike manner in accordance with approved hardware schedule. All items of hardware shall be secure and free working in the manner intended. Hardware shall be accurately mortised and fitted before painting. Hardware shall not be applied until the painting is finished. After hardware installation, the contractor shall cover all exposed surfaces of kick plates, push plates, pulls, locksets, exit devices, holders, etc., with a suitable covering, such as masking tape and polyethylene film to protect the hardware from scratches, abrasion, and tarnishing. This is to be left on until the building is completed and ready for final inspection. Upon completion of application, the contractor shall deliver to the Engineer for the Owner's maintenance personnel two copies of all installation instructions, templates, wrenches, installation tools, etc., supplied by the various manufacturers packed with the hardware necessary for installation and maintenance.

2.5 Delivery, Storage, and Handling: Hardware supplier shall receive and check all hardware at their warehouse. All hardware shall be delivered to the job site by the hardware supplier in one shipment. Drop shipments to the job site from the various manufacturers will not be permitted. All hardware shall be properly wrapped in separate packages complete with trimmings, screws, etc., each plainly labeled and numbered to agree with door numbers and contractor's typewritten schedule. The Contractor shall submit his schedules for correction and approval

to the Engineer before proceeding with any work. The hardware supplier shall repack all separate boxes and packages of hardware in cartons or cases and attach to the outside of each, a label indicating the manufacturer of the material, contents, quantity, item number on hardware schedule and door number before delivery to the job site. Hardware, when required, shall be delivered to the shops of the various door manufacturers properly marked and labeled following the same procedure outlined above for job site shipment.

2.6 The Contractor shall provide storage facilities for the finish hardware after delivery to the job site. A separate room, under lock and key, with shelves and bins as necessary to provide dry storage for all hardware items will be required.

3.0 HARDWARE INSTALLATION

3.1 Finish hardware on this project to be installed by personnel trained and certified by the manufacturer of the product scheduled to be supplied for this job. This certificate is to include the installation of locksets, exit device, mullion, closer, etc. The certified installer shall inspect door frames for correct installation (plum/square) and inform the Engineer if frames are ready for installation of doors and hardware. General Contractor shall correct all frames that are not properly installed. A pre-installation meeting of the job superintendent, certified installer, and the Engineer's hardware consultant of record is to be at the job site after all finish hardware has been delivered.

3.2 Electric hardware, if any, shall be installed by personnel trained and certified by the manufacturer of the products to be supplied for the project. This certificate is to include the installation of power transfer hinge, power transfer, power supply, electric lock, electric exit device, magnetic lock, automatic operator, electric interface, etc. A pre-installation meeting of the job superintendent, electrical contractor, certified installer, and the Engineer's hardware consultant of record is to be at the job site after all electric hardware has been delivered.

3.3 Finish hardware for aluminum doors on this project to be installed by personnel trained and certified by the manufacturer of the product scheduled to be supplied for this job. This certificate is to include the installation of pivot, continuous hinge, exit device, surface closer, floor closer, threshold, etc. A pre-installation meeting of the job superintendent, aluminum door/curtain wall supplier, certified installer, and the Engineer Hardware Consultant of record is to be at the job site after all aluminum hardware has been delivered. The certified installer's certificate shall be provided as a part of the Contractor's bid information; failure to supply this certificate may result in rejection of bid.

4.0 ITEMS NOT INCLUDED

4.1 Hardware for metal windows, toilet partitions, cabinets, access panels, etc., is not included in this specification. See other sections of the specifications for hardware to be furnished by others under such sections.

5.0 MATERIALS AND PRODUCTS

5.1 General: Materials and products specified herein have equally acceptable products from other manufacturers. To simplify hardware schedule, however, only one manufacturer's product is listed in hardware sets. In each case, product of manufacturer first named in specification is used in schedule. Where specific product of each manufacturer are not identified by series or catalog number, most comparable items of each manufacturer named to item specifically identified shall be considered equal of product identified. Where only a series of a manufacturer is named, other characteristics such as function shall be the same as for product specifically identified.

5.1.1 Hardware finishes shall be as follows unless specified in hardware sets:
US-26D - pivot, stop
US-32D - push plate, pulls, locks, hinge, flush bolt, exit device, protective plate
SS Series - door closer

5.2 Aluminum - threshold

5.3 Hinges - Hinges shall be five-knuckle construction. Hinges for exterior doors shall be solid bronze with non-rising removable pins, in the finish specified. Hinges for interior doors shall be steel, plated in the finish specified. Oil impregnated bearings are not an acceptable substitute for ball bearings. All hinges shall be 4½" x 4½" unless otherwise specified.

5.4 Pivot - Pivots for non-label openings shall be fenced bronze with plated finish as indicated. Pivots shall have ball and needle bearings with 3/4 offset. Pivots shall support a door weight of 450 pounds per set. Pivots for label openings shall be malleable iron and shall support a door weight of 350 pounds per set.

5.5 Lockset - All lever locks shall be mortise or bored type as indicated. Lock bodies and lock trim shall be by same manufacturer. Backset on all lever locks and deadlocks shall be 2-3/4". All deadlocks shall have 1" throw bolts and be equipped with armor fronts. Trim for lever mortise locks shall consist of case lever. Rose to be 2-9/16" diameter, with self-aligning thru bolts with fully concealed attachment. Bored locks shall have the feature that when the unit is locked the secured lever will be free wheeling. Trim for bored locks shall consist of cast lever. Rose to be 3-1/8" diameter. Bored locks shall have curved lip strike. Mortise locksets for single doors to have 1-1/4" curved lip strike, pairs of

doors to have 1-1/8" curved lip strike with strike box. Trim for locksets shall be as indicated in the hardware sets.

5.6 Exit Devices - Exit devices shall be rim type. Exit devices shall be operated by horizontal touch bar. Touch bar assembly shall have key dogging feature. Finish for exit devices shall be US-32D. Exit devices for UL doors shall be rim type or vertical rod type. Trim shall be of material, design, and dimensions as specified. Devices for label doors shall be listed with Underwriters Laboratories as fire exit hardware and shall have their label attached to the device.

5.7 Closers - Door closers shall be full rack and pinion type. Closers shall be surface mounted and shall project less than three (3) inches from surface of door or frame. Equip closers with two (2) key-operated regulating valves for individual control of both closing and latching speeds. Regulating valves shall be accessible from top of closer only and shall be completely unobtrusive. Closer shall have minimum of 50% door closing power adjustment and adjustable back check. Enclose closers in a cover of plastic. Mount closers without use of brackets or other obstructions in door opening. Closers on all exterior out-swinging doors and others as scheduled shall be parallel arm installation. Closer bodies and/or closer feet to be mounted on surface of doors shall be supplied with sex bolts.

5.8 Protective Plates - Kick and armor plates shall be height listed in schedule and width of 2" less than door width or 1" less than door width of each leaf on pairs of doors. Plates shall be 16 gauge stainless steel beveled 3 sides.

5.9 Thresholds - Provide (aluminum) thresholds where scheduled, with machine screws, lead expansion shields and R.C.E. feature.

5.10 Door Stops - Provide door stops wherever necessary to prevent door or hardware from striking an adjacent partition or obstruction. Provide wall type whenever possible. All door stops and holders mounted on concrete floor or masonry walls shall have machine screws and lead expansion shields. Provide stops at carpeted areas with ½" spacers.

5.11 Silencers - Provide GJ-64 silencers for all hollow metal frames. Single doors shall have three (3) silencers. Double doors shall have two (2) silencers.

5.12 Key Control System - Provide a complete key control system with 1 each (50) key capacity. Key control system shall be complete with a 16 gauge gray enamel, wall mounted locking cabinet. Provide collection envelopes, permanent key tags, loan key tags, 3-way cross index with binder, and permanent loan record with binder.

5.13 Keying - All lockset/cylinder to be keyed to existing master key system. Key locks in sets, and master key as directed by Owner. Obtain Owner’s approval and/or corrections before ordering locksets. Owner is to sign off on final approved

keying. Perform all keying at lock factory, and register key-data there. Deliver all to Engineer. Furnish keys in the following quantities:

a. 6 each Master Keys
b. 3 each Change Keys per lock or cylinder
c. 1 each Bitting List
d. 10 each Key Blanks per section used

6.0 APPLICATION

6.1 Installation - Work shall be done by a craftsman skilled and experienced in installation of finish hardware. Mortised items shall be neatly set in and made flush with door or frame surface. Manufacturer's instructions and recommendations shall be strictly followed.

6.2 Locations - Mortised items shall be installed at frame manufacturer's standard locations. Surface mounted items shall be installed at heights recommended by the Door and Hardware Institute, Arlington, Virginia.

6.3 Fasteners - Hinges, pivots, locks, and exit devices shall be installed with proper sex bolts, wood or machine screws as supplied by the manufacturer. Surface closers shall be mounted to door with sex bolts. Door pulls shall be installed on doors with thru-bolts as supplied by manufacturer. All removable mullion to be installed with mullion stabilizers. Exit devices to be installed with sex bolts.

DOOR HARDWARE SCHEDULE

HARDWARE SET 1

Quantity	Manufacturer	Item Description	Product Number
3 each	Hager	Hinge	BB1191
1 each	Yale	Lockset	PBR8805FL
1 each	Rixson	Surface Mount Overhead Stop	10-336

HARDWARE SET 2

Quantity	Manufacturer	Item Description	Product Number
3 each	Hager	Hinge	BB1191
1 each	Yale	Lockset	PBR8805FL
1 each	Rixson	Surface Mount Overhead Stop	10-236

HARDWARE SET 3

Quantity	Manufacturer	Item Description	Product Number
3 each	Hager	Hinge	BB1199 NRP
1 each	Yale	Lockset	PBR8822FL
1 each	Norton	Closer	UNI7500-H Series
1 each	Norton	Closer Space Block	6891
1 each	Norton	Closer Drop Plate	7788
1 each	Hager	Threshold	520S-MIL-NE
1 roll	Hager	Weather Strip	726S

HARDWARE SET 4

Quantity	Manufacturer	Item Description	Product Number
3 each	Hager	Hinge	BB1191
1 each	Yale	Rim Cylinder	1109 x 1765 Ring
1 each	Yale	Surface Vert. Rod Exit Device	7170F36 x MO626F
1 each	Hager	Kick Plate	193S x 8”
1 each	Norton	Closer - Corrosion Resistant	PA1601SS
1 each	Rixson	Overhead Hold Open	9-326 x 5458/5459 Bracket
1 each	Hager	Intumescent / Smoke Seal	720S
1 each	Hager	Smoke Astragal	802S-DBA-B

HARDWARE SET 5

Quantity	Manufacturer	Item Description	Product Number
3 each	Hager	Hinge	BB1199 NRP
1 each	Yale	Lockset	PBR8822FL
1 each	Hager	Kick Plate	193S x 8”
1 each	Norton	Closer – Corrosion Resistant	PA1601SS
1 each	Hager	Wall Stop/Holder	326W

DOOR HARDWARE SCHEDULE CONT.

1 each	Hager	Cast Aluminum Threshold	627S x 5”
1 roll	Hager	Weather Strip	726S
1 each	Hager	Door Sweep	750S-CLR-N

HARDWARE SET 6

Quantity	Manufacturer	Item Description	Product Number
12 each	Hager	Hinge	BB1199 NRP
1 each	Yale	Deadlock	315
2 each	Ives	Top Bolt	Spring Bolt with Chain US2C
2 set	Ives	Surface Bolt	Kick Down US2C
2 each	Rixson	Overhead Hold Open	9-426 x 5458/5459 Bracket
1 each	Hager	Cast Aluminum Threshold	627S x 5”
1 set	-	Weather Strip	Neoprene for Monorail
1 roll	Hager	Weather Strip	726S
2 each	Hager	Sweep	750S-CLR-N

Note: Astragal to be supplied by FRP door supplier.

END OF SECTION

SECTION 09300

RESILIENT TILE FLOORING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Flooring and accessories as shown on the drawings and schedules and as indicated by the requirements of this section.
B. Related Documents
   1. Drawings and General Provisions of the Contract (including General and Supplementary Conditions and Division 1 sections) apply to the work of this section.

1.02 REFERENCES

A. ASTM International:
   1. ASTM E 648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
   2. ASTM E 662 Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
   3. ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
   4. ASTM F 1066 Standard Specification for Vinyl Composition Tile
   5. ASTM F 1861 Standard Specification for Resilient Wall Base
   6. ASTM F 1869 Standard Test Method for Measuring Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
   7. ASTM F 2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes

B. National Fire Protection Association (NFPA):
   1. NFPA 253 Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
   2. NFPA 258 Standard Test Method for Measuring the Smoke Generated by Solid Materials

1.03 SYSTEM DESCRIPTION

A. Performance Requirements: Provide flooring which has been manufactured, fabricated and installed to performance criteria certified by manufacturer without defects, damage, or failure.

B. Administrative Requirements
   1. Pre-installation Meeting: Conduct an on-site pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings) Section.

C. Sequencing and Scheduling
   1. Install flooring and accessories after the other finishing operations, including painting, have been completed. Close spaces to traffic during the installation of the flooring.
   2. Do not install flooring over concrete slabs until they are sufficiently dry to achieve a bond with the adhesive, in accordance with the manufacturer's recommended bond, moisture tests and pH test.

1.04 SUBMITTALS

A. Submit shop drawings, seaming plan, coving details, and manufacturer's technical data, installation and maintenance instructions for flooring and accessories.

B. Submit the manufacturer's standard samples showing the required colors for flooring and applicable accessories.

C. Submit Safety Data Sheets (SDS) available for adhesives, moisture mitigation systems, primers, patching/leveling compounds, floor finishes (polishes), and cleaning agents and Material Information Sheets for flooring products.

D. If required, submit the manufacturer's certification that the flooring has been tested by an independent laboratory and complies with the required fire tests.

E. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Section. Include methods for maintaining installed products, and precautions against cleaning materials and methods detrimental to finishes and performance.
   2. Warranty: Warranty documents specified herein

1.05 QUALITY ASSURANCE

A. Single-Source Responsibility: provide flooring and accessories supplied by one manufacturer, including any necessary moisture mitigation systems, primers, leveling and patching compounds, and adhesives.

B. Select an installer who is experienced and competent in the installation of resilient vinyl composition tile flooring and the use of subfloor preparation products.

C. Fire Performance Characteristics: Provide resilient vinyl composition tile flooring with the following fire performance characteristics as determined by testing material in accordance with ASTM test methods indicated below by a certified testing laboratory or other testing agency acceptable to authorities having jurisdiction:
   1. ASTM E 648 Critical Radiant Flux of 0.45 watts per sq. cm. or greater, Class I
   2. ASTM E 662 (Smoke Generation) Maximum Specific Optical Density of 450 or less
   3. CAN/ULC-S102.2 – Flame Spread Rating and Smoke Developed – Results as tested.

1.06 DELIVERY, STORAGE AND HANDLING

A. Comply with Division 1 Product Requirements Sections.

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

C. Deliver materials in good condition to the jobsite in the manufacturer's original unopened containers that bear the name and brand of the manufacturer, project identification, and shipping and handling instructions.

D. Store materials in a clean, dry, enclosed space off the ground, protected from harmful weather conditions and at temperature and humidity conditions recommended by the manufacturer. Protect adhesives from freezing. Store flooring, adhesives and accessories in the spaces where they will be installed for at least 48 hours before beginning installation.

1.07 PROJECT CONDITIONS

A. Maintain a minimum temperature in the spaces to receive the flooring and accessories of 65ºF and a maximum temperature of 85ºF for at least 48 hours before, during, and for not less than 48 hours after installation. Thereafter, maintain a minimum temperature of 55ºF in areas where work is completed. Protect all materials from the direct flow of heat from hot-air registers, radiators, or other heating fixtures and appliances.

1.08 LIMITED WARRANTY

A. Resilient Flooring: Submit a written warranty executed by the manufacturer, agreeing to repair or replace resilient flooring that fails within the warranty period.

B. Limited Warranty Period: 5 years

C. Limited Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and

run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

D. For the limited warranty to be valid, this product is required to be installed using the appropriate manufacturer's installation system and methods. Products that are installed not using the specific instructions from the manufacturer will void the warranty.

1.09 EXTENDED SYSTEM LIMITED WARRANTY

A. Resilient Flooring System: Submit a written warranty executed by the manufacturer, agreeing to repair or replace system (subfloor preparation products, adhesive, and floor covering) that fails within the warranty period.

B. Limited Warranty Period: 10 years on top of the Resilient Flooring Limited Warranty

C. Cement based self-leveling compound

D. The installation of an approved product along with the recommended flooring adhesive, as well as the proper subfloor preparation product listed above, the manufacturer shall provide 10 additional years of limited warranty coverage.

E. All flooring products are to be free from manufacturing defects from the date of purchase through a manufacturer's warranty period of 15 years.

1.10 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials from same production run as products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Quantity: Furnish quantity of flooring units equal to 5% of amount installed.
2. Delivery, Storage and Protection: Comply with Owner's requirements for delivery, storage and protection of extra material.

PART 2 – PRODUCTS

2.01 MANUFACTURER

A. Resilient tile flooring, wall base, adhesives and subfloor preparation products and accessories shall be as provided by:

Armstrong Flooring Inc., or approved equal.

2.02 RESILIENT TILE FLOORING MATERIALS

A. Provide Vinyl Composition Tile: Standard Excelon® Imperial® Texture Tile Flooring manufactured by Armstrong Flooring, Inc., or approved equal.
   1. Description: Tile composed of polyvinyl chloride resin, plasticizers, fillers, stabilizers and pigments with colors and texture dispersed uniformly throughout its entire thickness.
   2. Vinyl composition tile shall conform to the requirements of ASTM F 1066, “Standard Specification Vinyl Composition Floor Tile", Class 2, through-pattern
   3. Pattern and Color: Color to be selected by owner.
   4. Size: 12 in. x 12 in.
   5. Thickness: 3/32"/0.095 in.

2.03 WALL BASE MATERIALS

A. For top set wall base: Provide 0.080 in. thick by 4 in. high color-integrated wall base with a matte finish, conforming to ASTM F 1861 Type TV - Vinyl, Thermoplastic, Group 1 - Solid, Style B – Cove. Color to be selected by owner.

2.04 ADHESIVES

A. Full Spread: Provide Armstrong S-515 Floor Tile Adhesive under the tile and Armstrong S-725 Wall Base Adhesive at the wall base, or as recommended by the flooring manufacturer.

2.05 ACCESSORIES

A. For patching, smoothing, and leveling monolithic subfloors (concrete, terrazzo, quarry tile, ceramic tile, and certain metals), provide Armstrong S-453 Level Strong™ cement based self-leveling compound.

B. For sealing joints between the top of wall base or integral cove cap and irregular wall surfaces such as masonry, provide plastic filler applied according to the manufacturer's recommendations.

C. Provide transition/reducing strips tapered to meet abutting materials.

D. Provide threshold of thickness and width as shown on the drawings.

E. Provide resilient edge strips of width shown on the drawings, of equal gauge to the flooring, homogeneous vinyl or rubber composition, tapered or bullnose edge, with color to match or contrast with the flooring, or as selected by the owner from standard colors available.

F. Provide metal edge strips of width shown on the drawings and of required thickness to protect exposed edges of the flooring. Provide units of maximum available length to minimize the number of joints. Use butt-type metal edge strips for concealed anchorage, or overlap-type metal edge strips for exposed anchorage. Unless otherwise shown, provide strips made of extruded aluminum with a mill finish.

PART 3 – EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog, installation instructions, and product carton instructions for installation and maintenance procedures as needed.

3.02 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions (i.e. moisture tests, bond test, pH test, etc.).

B. Visually inspect flooring materials, adhesives and accessories prior to installation. Flooring material with visual defects shall not be installed and shall not be considered as a legitimate claim.

C. Examine subfloors prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond or impair durability or appearance of the flooring material.

D. Inspect subfloors prior to installation to determine that surfaces are free from curing, sealing, parting and hardening compounds; residual adhesives; adhesive removers; and other foreign materials that might prevent adhesive bond. Visually inspect for evidence of moisture, alkaline salts, carbonation, dusting, mold, or mildew.

E. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

F. Failure to call attention to defects or imperfections will be construed as acceptance and approval of the subfloor. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation.

3.03 PREPARATION

A. Subfloor Preparation and Moisture Mitigation: Smooth concrete surfaces, removing rough areas, projections, ridges, and bumps, and filling low spots, control or construction joints, mitigate moisture and other defects with Armstrong Flooring S-453 Level Strong™ cement based self-leveling compound and in accordance with ASTM F 710 Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.

B. Subfloor Cleaning: The surface shall be free of dust, solvents, varnish, paint, wax, oil, grease, sealers, release agents, curing compounds, residual adhesive, adhesive removers and other foreign materials that might affect the adhesion of resilient flooring to the concrete or cause a discoloration of the flooring from below. Remove residual adhesives as recommended by the flooring manufacturer. Remove curing and hardening compounds not compatible with the adhesives used, as indicated by a bond test or by the compound manufacturer's recommendations for flooring. Avoid organic solvents. Spray paints, permanent markers and other indelible ink markers must not be used to write on the back of the flooring material or used to mark the concrete slab as they could bleed through, telegraphing up to the surface and permanently staining the flooring material. If these contaminants are present on the substrate they must be mechanically removed prior to the installation of the flooring material.

C. For Tile High-Moisture Installation Warranty when using S-515 Adhesive, perform subfloor moisture testing in accordance with ASTM F 1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride and Bond Tests as described in the flooring manufacturer’s installation instructions, to determine if surfaces are dry; free of curing and hardening compounds, old adhesive, and other coatings; and ready to receive flooring. On installations where both the Percent Relative Humidity and the Moisture Vapor Emission Rate tests are conducted, results for both tests shall comply with the allowable limits listed in the manufacturer’s recommendations. Do not proceed with flooring installation until results of moisture tests are acceptable. All test results shall be documented and retained.

D. Concrete pH Testing: Perform pH tests on concrete floors regardless of their age or grade level. All test results shall be documented and retained.

E. Vacuum or broom-clean surfaces to be covered immediately before the application of flooring.

3.04 INSTALLATION OF FLOORING

A. Install flooring in strict accordance with the latest edition of manufacturer’s installation manual. Failure to comply may result in voiding the manufacturer’s warranty listed in Section 1.08.

B. Install flooring wall to wall before the installation of floor-set cabinets, casework, furniture, equipment, movable partitions, etc. Extend flooring into toe spaces, door recesses, closets, and similar openings as shown on the drawings.

C. If required, install flooring on pan-type floor access covers. Maintain continuity of color and pattern within pieces of flooring installed on these covers. Adhere flooring to the subfloor around covers and to covers.

D. Scribe, cut, and fit to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets.

E. Install flooring with adhesives, tools, and procedures in strict accordance with the manufacturer's written instructions. Observe the recommended adhesive trowel notching, open times, and working times.

3.05 INSTALLATION OF ACCESSORIES

A. Apply top set wall base to walls, columns, casework, and other permanent fixtures in areas where top-set base is required. Install base in lengths as long as practical, with inside corners fabricated from base materials that are mitered or coped. Tightly bond base to vertical substrate with continuous contact at horizontal and vertical surfaces.

B. Fill voids with plastic filler along the top edge of the resilient wall base or integral cove cap on masonry surfaces or other similar irregular substrates.

C. Place resilient edge strips tightly butted to flooring, and secure with adhesive recommended by the edge strip manufacturer. Install edge strips at edges of flooring that would otherwise be exposed.

D. Apply overlap metal edge strips where shown on the drawings, after flooring installation. Secure units to the substrate, complying with the edge strip manufacturer's recommendations.

3.06 CLEANING

A. Perform initial cleaning in accordance with manufacturer’s written instructions.

3.07 PROTECTION

A. Contractor shall protect all installed flooring as recommended by the flooring manufacturer against damage from rolling loads, other trades, or the placement of fixtures and furnishings.

END OF SECTION

SECTION 09510

ACOUSTIC CEILING TILES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. PVC ceiling panels and installation.

1.2 REFERENCES

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. CISCA (Ceilings & Interior Systems Contractors Association):

1. Ceiling Systems Handbook.

2. Acoustic Ceilings: Use and Practice.

1.3 SUBMITTALS FOR REVIEW

A. Product Data: Provide data on PVC panel construction and detailed cleaning instructions.

B. Panel Samples: Submit two samples of each size and color specified

C. Grid Samples: Submit two samples of each size and color specified

1.4 QUALITY ASSURANCE

A. Conform to CISCA requirements.

1.5 PROJECT CONDITIONS

A. Sequence work to ensure ceilings are not installed:

1. Until building is enclosed,

2. Sufficient heat is provided,

3. Dust generating activities have terminated

4. Overhead work is completed, tested, and approved.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

B. Store cartons laid flat, protected from exposure to sun, high temperatures or humidity conditions as recommended by the manufacturer.

1.7 EXTRA MATERIALS

A. Provide to the Owner a quantity of 5 percent of all panel types provided for the Work.

1.8 WARRANTY

A. Limited Warranty: Ten (10) years from product manufacturing defects.

PART 2 – PRODUCTS

2.1 CEILING PANELS

A. Manufacturers:

1. Genesis Ceiling Panels, by Acoustic Ceiling Products

2. Or Equal

B. Material:

1. Material: Virgin grade polyvinyl chloride (PVC), 0.76 to 0.81 mm (0.030 to 0.032 inches) thick, 2’ wide x 2’ long panels are to be provided for this project.

C. Finish: Classic Pro, White

D. Light Reflectance:

1. Per ASTM E1477, Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.

Ceiling Tile Style	Color	% Luminous Reflectance (LRV)
Smooth	White	84.6
Classic	White	78.6
Stucco	White	84.2

2.2 ACCESSORIES

A. Moldings: T-Bar and J-Trim, color white to match ceiling panel

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of panels will not interfere with other work.

3.2 INSTALLATION

A. Install assembly in accordance with manufacturer's instructions and as supplemented in this section.

B. Lay out assembly to a balanced grid design with edge units no less than 50 percent of acoustic unit size.

C. Cutting Panels: Using a utility knife and straight edge, score the finish side of the panel. Bend panel at the score mark and snap apart.

D. T-bar Panel Mount:

1. Install border panels, then full panels working across the ceiling area.

2. To cut panels, measure distance between t-bar centers, or between the t-bar center and closest edge of wall molding.

F. Perimeter Molding:

1. Install edge molding at intersection of ceiling and vertical surfaces into bead of acoustic sealant that is not visible after installation.

2. Use single piece longest practical lengths.

3. Miter corners.

END OF SECTION

SECTION 09960

HIGH PERFORMANCE COATINGS

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Coating systems for water processing facilities.

1.2 REFERENCES

ASTM B 117-99 (2007) – Standard Practice for Operating Salt Spray (Fog) Apparatus.

ASTM D 4263 - Indicating Moisture in Concrete by the Plastic Sheet Method.

ASTM F 1869 - Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

International Concrete Repair Institute (ICRI) Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

NACE RP0188 - Standard Recommended Practice, Discontinuity (Holiday) Testing of Protective Coatings.

NAPF 500-03-04 Abrasive Blast Cleaning.

NAPF 500-03-03 Power Tool Cleaning.

SSPC-SP 1 - Solvent Cleaning.

SSPC-SP 6/NACE 3 - Commercial Blast Cleaning.

SSPC-SP 10/NACE 2 - Near-White Metal Blast Cleaning.

SSPC-SP 13/NACE 6 - Surface Preparation of Concrete.

ASTM C 413-01 (2006) – Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.

ASTM C 868-02 (2008) – Standard Test Method for Chemical Resistance of Protective Linings.

ASTM D 149-09 – Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power

Frequencies.

ASTM D 870-09 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.

ASTM D 1653-03 (2008) – Standard Test Methods for Water Vapor Transmission of Organic Coating Films.

ASTM D 2370-98 (2002) Standard Test Method for Tensile Properties of Organic Coatings.

1.3 DEFINITIONS

A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.

B. Dry Film Thickness (DFT): Thickness of a coat of cured paint measured in mils (1/1000 inch).

1.4 SUBMITTALS

A. Comply with Section 01 - Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.

C. Color Samples: Submit manufacturer's color samples showing full range of standard colors.

D. Manufacturer's Quality Assurance: Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

E. Applicator's Quality Assurance: Submit list of a minimum of 5 completed projects of similar size and complexity to this Work. Include for each project:
1. Project name and location.
2. Name of owner.
3. Name of contractor.
4. Name of engineer.
5. Name of coating manufacturer.
6. Approximate area of coatings applied.
7. Date of completion.

F. Warranty: Submit manufacturer's standard warranty.

1.5 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:

1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
2. Able to demonstrate successful performance on comparable projects.
3. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.

B. Applicator’s Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.
2. Applicator's Personnel: Employ persons trained for application of specified coatings.

C. Pre-application Meeting: Convene a preapplication meeting two [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer’s representative. Review the following:

Environmental requirements.
Protection of surfaces not scheduled to be coated.
Surface preparation.
Application.
Repair.
Field quality control.
Cleaning.
Protection of coating systems.
One-year inspection.
Coordination with other work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:

1. Coating or material name.
2. Manufacturer.
3. Color name and number.
4. Batch or lot number.
5. Date of manufacture.
6. Mixing and thinning instructions.

B. Storage:

1. Store materials in a clean dry area and within temperature range in accordance with manufacturer's instructions.
2. Keep containers sealed until ready for use.

3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Weather:
1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.
2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.
3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.
4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.
5. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants:
1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

PART 2 – PRODUCTS

2.1 MANUFACTURER

A. Tnemec Company Inc., Rust-oleum, C.I.M. Industries Inc., or approved equal.

2.2 COATING SYSTEMS FOR STEEL - STRUCTURAL, TANKS, PIPE, EQUIPMENT, AND MISCELLANEOUS

A. Exterior Exposed:
1. System Type: MCU/epoxy/urethane.
2. Surface Preparation: SSPC-SP 6.
3. Primer: Series 94-H_20 Hydro-Zinc. DFT 2.5 to 3.5 mils.
4. Intermediate Coat: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
5. Finish Coat: Series 740 UVX Endura-Shield. DFT 3.0 to 4.0 mils.
6. Total DFT: 8.5 to 11.0 mils.
7. Finish Color: As shown on drawings or as selected by owner.

B. Interior Exposed:

1. System Type: MCU/epoxy.
2. Surface Preparation: SSPC-SP 6.
3. Primer: Series 94H20 Hydro-Zinc. DFT 2.0 to 3.0 mils.
4. Finish Coat: Series 66HS Hi-Build Epoxoline. DFT 4.0 to 6.0 mils.
5. Total DFT: 6.0 to 9.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

C. Immersion:

1. System Type: MCU/epoxy.
2. Surface Preparation: SSPC-SP 10.
3. Primer: Series 94H20 Hydro-Zinc. DFT 2.0 to 3.0 mils.
4. Intermediate Coat: Series N140 Pota-Pox Plus. DFT 4.0 to 6.0 mils.
5. Finish Coat: Series N140 Pota-Pox Plus. DFT 4.0 to 6.0 mils.
6. Total DFT: 10.0 to 15.0 mils.
7. Finish Color: As shown on drawings or as selected by owner.

2.3 COATING SYSTEMS FOR GALVANIZED STEEL AND NONFERROUS METAL - PIPE AND MISCELLANEOUS FABRICATIONS

A. Exterior Exposed:

1. System Type: Epoxy/urethane.
2. Surface Preparation: SSPC-SP 1 - Solvent Cleaning and etch.
3. Primer: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 740 UVX. DFT 2.0 to 3.0 mils.
5. Total DFT: 5.0 to 8.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

B. Interior Exposed:

1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 1 - Solvent Cleaning and etch.
3. Primer: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
5. Total DFT: 6.0 to 10.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

C. Immersion:

1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 1 followed by abrasive blast.
3. Primer Coat: Series N140 Pota-Pox Plus. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series N140 Pota-Pox Plus. DFT 4.0 to 6.0 mils.
5. Total DFT: 7.0 to 11.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

2.4 COATING SYSTEMS FOR DUCTILE OR CAST IRON - PIPE, PUMPS, AND VALVES

A. Exterior Exposed:

1. System Type: MCU/epoxy/urethane.
2. Surface Preparation: NAPF 500-03-03 Power Tool Cleaning.
3. Primer: Series 1 Omnithane. DFT 2.5 to 3.5 mils.
4. Intermediate Coat: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
5. Finish Coat: Series 740 UVX. DFT 2.0 to 3.0 mils.
6. Total DFT: 7.5 to11.5 mils.
7. Finish Color: As shown on drawings or as selected by owner.

B. Below Ground:

1. System Type: Coal tar epoxy.
2. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning.
3. Finish Coat: Series 46H-413 Hi-Build Tneme-Tar. DFT 14.0 to 20.0 mils.
4. Total DFT: 14.0 to 20.0 mils.
5. Finish Color: Black.

C. Interior Exposed:

1. System Type: MCU/Epoxy.
2. Surface Preparation: Surface Preparation: NAPF 500-03-03 Power Tool Cleaning.
3. Primer: Series 1 Omnithane. DFT 2.5 to 3.5 mils.
4. Finish Coat: Series 66HS Hi-Build Epoxoline. DFT 4.0 to 6.0 mils.
5. Total DFT: 6.5 to 9.5 mils.
6. Finish Color: Color shall be grey, with flanges painted to adhere to the following Schedule:

Raw or Recycled Water	Olive Green
Settled or Clarified Water	Aqua
Finished or Potable Water	Dark Blue
Backwash Waste Water	Light Brown
Sludge	Dark Brown
Sewer (Sanitary or Other)	Dark Gray
Compressed Air	Dark Green
Gas	Red
Other Lines	Gray with Labeling

D. Immersion:

1. System Type: MCU/Epoxy.
2. Surface Preparation: NAPF 500-03-04 Abrasive Blast Cleaning.
3. Primer: Series 1 Omnithane. DFT 2.5 to 3.5 mils.
4. Intermediate Coat: Series N69 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
5. Finish Coat: Series N69 Hi-Build Epoxoline II. DFT 4.0 to 6.0 mils.
6. Total DFT: 10.5 to 15.5 mils.

2.5 COATING SYSTEMS FOR PVC

A. Exterior Exposed:
1. System Type: Epoxy/urethane.
2. Surface Preparation: Scarify.
3. Primer: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 740 Endura-Shield. DFT 2.0 to 3.0 mils.
5. Total DFT: 5.0 to 8.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

B. Interior Exposed:
1. System Type: Epoxy.
2. Surface Preparation: Scarify.
3. Primer: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
4. Finish Coat: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
5. Total DFT: 6.0 to 10.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

2.6 COATING SYSTEMS FOR INSULATED PIPE

A. Interior/Exterior Exposed:
1. System Type: Acrylic.
2. Surface Preparation: Clean and dry.
3. Primer: Series 1028 Tufcryl. DFT 1.5 to 2.0 mils.
4. Finish Coat: Series 1028 Tufcryl. DFT 1.5 to 2.0 mils.
5. Total DFT: 2.0 to 3.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

2.7 COATING SYSTEMS FOR PRECAST CONCRETE, CAST-IN-PLACE CONCRETE, AND DENSE CONCRETE MASONRY UNITS

A. Exterior Exposed:
1. System Type: Acrylate.
2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
3. Primer: Series 156 Enviro-Crete. Spreading Rate 125 sf/gal.
4. Finish Coat: Series 156 Enviro-Crete. Spreading Rate 200 sf/gal.
6. Finish Color: As shown on drawings or as selected by owner.

B. Below Grade:
1. System Type: Coal tar epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
3. Primer: None.
4. Finish Coat: 46H-413 Hi-Build Tneme-Tar. DFT 14.0 to 20.0 mils.
5. Total DFT: 14.0 to 20.0 mils.
6. Finish Color: Black.

C. Immersion:

1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-3.
3. Primer: Series N140 Pota-Pox Plus. DFT 3.0 to 5.0 mils.
4. Intermediate Coat: Series N140 Pota-Pox Plus. DFT 4.0 to 6.0 mils.
5. Finish Series N140 Pota-Pox Plus. DFT 4.0 to 6.0 mils.
6. Total DFT: 11.0 to 17.0 mils.
7. Finish Color: As shown on drawings or as selected by owner.

E. Interior Exposed:

1. System Type: Epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-3.
3. Primer: Series 66HS Hi-Build Epoxoline. DFT 4.0 to 6.0 mils.
4. Finish Coat: Series 66HS Hi-Build Epoxoline. DFT 4.0 to 6.0 mils.
5. Total DFT: 8.0 to 12.0 mils.
6. Finish Color: As shown on drawings or as selected by owner.

2.8 COATING SYSTEMS FOR CONCRETE FLOORS

A. Light Traffic/Low Impact Exposure:

1. System Type: High-solids epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-3.
3. Primer: Series 201 Epoxoprime. DFT 6.0 to 8.0 mils.
4. Intermediate Coat: Series 280 Tneme-Glaze. DFT 6.0 to 8.0 mils.
5. Finish Coat: Series 280 Tneme-Glaze. DFT 6.0 to 8.0 mils.
6. Total DFT: 18.0 to 24.0 mils.
7. Finish Color: As shown on drawings or as selected by owner. [Limited Color Selection]

B. Heavy Traffic and Chemical Exposure:

1. System Type: Aggregate-filled epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-5.
3. First Coats: Series 237 Power-Tread, double broadcast. DFT 1/8 inch.
4. Intermediate Coat: Series 280 Tneme-Glaze. DFT 6.0 to 8.0 mils.
5. Finish Coat: Series 291 CRU. DFT 2.0 to 3.0 mils.
6. Total DFT: Greater than 1/8 inch.
7. Finish Color: As shown on drawings or as selected by owner. [Limited Color Selection]

C. Decorative:

1. System Type: Ceramic-filled epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732,

CSP-5.
3. Primer: Series 201 Epoxoprime. DFT 4.0 to 6.0 mils.
4. Intermediate Coat: Series 222 Deco-Tread, double broadcast. DFT 1/8 inch.
5. Finish Coat: Series 285 Satinglaze. DFT 8.0 to 10.0 mils.
6. Total DFT: Greater than 1/8 inch.
7. Finish Color: As shown on drawings or as selected by owner.

2.9 COATING SYSTEMS FOR SECONDARY CONTAINMENT

A. Chemical Storage Containment Area
1. System Type: High-solids epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-5.
3. Primer: Series 201 Epoxoprime. DFT 6.0 to 8.0 mils.
4. Intermediate Coat: Series 275 Stranlock. DFT 25.0 to 40.0 mils.
5. Finish Coat: Series 282 Tneme-Glaze. DFT 8.0 to 12.0 mils.
6. Total DFT: 39.0 to 60 mils.
7. Finish Color: As shown on drawings or as selected by owner. [Limited Color Selection]

B. Floors, Severe Chemical, Abrasion, and Traffic Exposure:
1. System Type: Aggregate-filled epoxy novalac.
2. Surface Preparation: SSPC-SP 13/NACE 6 and ICRI Guideline 03732, CSP-5.
3. First Coats: Series 239 Chemtread, double broadcast. DFT 1/8 inch.
4. Finish Coat: Series 282 Tneme-Glaze. DFT 6.0 to 8.0 mils.
5. Total DFT: Greater than 1/8 inch (125 mils).
6. Finish Color: As shown on drawings or as selected by owner. [Limited Color Selection]

2.10 COATING SYSTEMS FOR POROUS CONCRETE MASONRY UNITS

A. Exterior Exposed:
1. System Type: Acrylate.
2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
3. Primer: Series 156 Enviro-Crete. Spreading rate 80 to 100 sq. ft/gal.
4. Finish Coat: Series 156 Enviro-Crete. Spreading rate 125 sq. ft/gal.
5. Finish Color: As shown on drawings or as selected by owner.

B. Interior Exposed:
1. System Type: Cementious Acrylic/epoxy.
2. Surface Preparation: SSPC-SP 13/NACE 6. Clean and dry.
3. Primer: Series 130 Masonry Filler. Spreading rate 80 to 100 sq. ft/gal.
4. Intermediate Coat: Series 66HS Hi-Build Epoxoline. DFT 3.0 to 5.0 mils.
5. Finish Coat: Series N69 Hi-Build Epoxoline II. DFT 3.0 to 5.0 mils.

6. Total DFT: 6.0 to 10.0 mils plus filler.
7. Finish Color: As shown on drawings or as selected by owner.

2.11 COATING SYSTEMS FOR PLASTER, GYPSUM BOARD, AND WOOD

A. Interior Exposed:
1. System Type: Epoxy/acrylic-epoxy.
2. Surface Preparation: Clean and dry.
3. Primer: Series 151-1051 Elasto-Grip FC. DFT 1.0 to 1.5 mils.
4. Intermediate Coat: Series 113 H.B. Tneme-Tufcoat. DFT 2.0 to 3.0 mils.
5. Finish Coat: Series 113 H.B. Tneme-Tufcoat. DFT 2.0 to 3.0 mils.
6. Total DFT: 5.0 to 7.5 mils.
7. Finish Color: As shown on drawings or as selected by owner.

2.12 CIM COATING SYSTEM FOR CONCRETE

A. Interior or Exterior Exposed:
1. System Type: Waterproof Elastomeric Membrane Coating
2. Surface Preparation: Clean and Dry, ICRI-CSP 4-6
3. Finish Coat: CIM 1061
4. Total DFT: 60.0 to 70.0 mils.
5. Finish Color: Black

2.13 ACCESSORIES

A. Coating Application Accessories:
1. Accessories required for application of specified coatings in accordance with manufacturer's instructions, including thinners.
2. Products of coating manufacturer.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

3.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.3 SURFACE PREPARATION OF STEEL

A. Prepare steel surfaces in accordance with manufacturer's instructions.

B. Fabrication Defects:
1. Correct steel and fabrication defects revealed by surface preparation.
2. Remove weld spatter and slag.
3. Round sharp edges and corners of welds to a smooth contour.
4. Smooth weld undercuts and recesses.
5. Grind down porous welds to pinhole-free metal.
6. Remove weld flux from surface.

C. Ensure surfaces are dry.

D. Immersion or Below Grade Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 10/NACE 2. Create a blast profile of 1.5 to 2.5 mils.

E. Exterior Exposed or Interior Exposed Surfaces: Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3. Create a blast profile of 1.5 to 2.5 mils.

F. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.

G. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions. Removal all unknown shop primers and re-prime in accordance with this specification.

3.4 SURFACE PREPARATION OF GALVANIZED STEEL AND NONFERROUS METAL

A. Prepare galvanized steel and nonferrous metal surfaces in accordance with this specification and the coating manufacturer's instructions.

B. Ensure surfaces are dry.

C. Immersion Service: Clean surfaces by abrasive blasting.

D. Remove Rust From Galvanized Steel:
1. Remove white rust from galvanized steel by hand or power brushing.
2. Do not damage or remove galvanizing.

E. Increase mechanical adhesion under moderate to severe conditions, such as exterior exposure or chemical environments, by abrasive blast and/or chemical

cleaning.

3.5 SURFACE PREPARATION OF DUCTILE OR CAST IRON

A. Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning, NAPF 500-03-03 Power Tool Cleaning and the coating manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.6 SURFACE PREPARATION OF PVC

A. Prepare PVC surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Scarify PVC surfaces.

3.7 SURFACE PREPARATION OF INSULATED PIPE

A. Prepare insulated pipe surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

3.8 SURFACE PREPARATION OF CONCRETE

A. Interior, Wet Substrate:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Allow concrete to cure for a minimum of 28 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill holes, pits, voids, and cracks with manufacturer approved surfacer.
7. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

B. Exterior and Interior Dry:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.
2. Allow concrete to cure for a minimum of 14 days.
3. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.
4. Level concrete protrusions and mortar spatter.
5. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.
6. Fill hairline cracks less than 1/64 inch (0.4 mm) in accordance with manufacturer's instructions.
7. Prepare cracks wider than 1/64 inch (0.4 mm), moving cracks, gaps, and expansion joints in accordance with manufacturer's instructions.
8. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

3.9 SURFACE PREPARATION OF CONCRETE FLOORS

A. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow concrete to cure for a minimum of 28 days before coating.

D. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.

E. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.

3.10 SURFACE PREPARATION OF SECONDARY CONTAINMENT

A. Prepare secondary containment surfaces in accordance with manufacturer's instructions.

B. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.

C. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

D. Allow concrete to cure for a minimum of 28 days before coating.

E. Test concrete for moisture in accordance with ASTM D 4263 and, if necessary, F 1869.

F. Verify that the pH of the cleaned concrete surfaces to be coated is within the range of to 8 to 11. Application of coating materials outside this range will not be permitted without written approval from the Engineer.

3.11 SURFACE PREPARATION OF POROUS CONCRETE MASONRY UNITS

A. Prepare porous concrete masonry unit surfaces in accordance with manufacturer's instructions and SSPC-SP 13/NACE 6.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow mortar to cure for a minimum of 28 days before coating.

D. Level protrusions and mortar spatter.

3.12 SURFACE PREPARATION OF PLASTER

A. Prepare plaster surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Allow plaster to cure and dry out for a minimum of 28 days before coating.

D. Do not coat over plaster containing free water, lime, or other soluble alkaline salts.

E. Remove plaster nibs and other protrusions.

F. Patch voids and cracks with approved materials and after dry, sand flush with surface.

3.13 SURFACE PREPARATION OF GYPSUM BOARD

A. Prepare gypsum board surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

C. Sand joint compound smooth and feather edge.

D. Avoid heavy sanding of adjacent gypsum board surfaces, which will raise nap of paper covering.

E. Do not apply putty, patching pencils, caulking, or masking tape to drywall surfaces to be painted.

F. Lightly scuff-sand tape joints after priming to remove raised paper nap. Do not sand through primer.

3.14 SURFACE PREPARATION OF WOOD

A. Prepare wood surfaces in accordance with manufacturer's instructions.

B. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, surface deposits of sap or pitch, and other contaminants.

C. Seal knots and pitch pockets.

D. Sand rough spots with the grain.

E. Fill cracks and holes with approved materials after primer is dry. Sand flush with surface when filler is hard.

F. Lightly sand between coats.

3.15 APPLICATION

A. Apply coatings in accordance with manufacturer's instructions.

B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer. Apply and additional strip coat of the intermediate coating

material in immersion areas.

3.16 REPAIR

A. Materials and Surfaces Not Scheduled to Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.17 FIELD QUALITY CONTROL

A. Required Inspections and Documentation:

1. Verify coatings and other materials are as specified.
2. Verify surface preparation and application are as specified.
3. Verify DFT of each coat and total DFT of each coating system are as specified using wet film and dry film gauges.
4. Coating Defects: Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
    a. Check for holidays on interior steel immersion surfaces using holiday detector.
5. Report:
    a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
    b. Report nonconforming work not corrected.
    c. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.19 CLEANING

A. Remove temporary coverings and protection of surrounding areas and surfaces.

3.20 PROTECTION OF COATING SYSTEMS

A. Protect surfaces of coating systems from damage during construction.

3.21 WARRANTY

A. Owner will set date for one-year inspection of coating systems.

B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.

C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

END OF SECTION

SECTION 11027

SAMPLE PUMPS

1.0 – GENERAL

1.1 SCOPE OF WORK

The CONTRACTOR shall furnish all labor, tools, equipment, materials, and perform all work and services necessary for or incidental to the furnishing and complete installation of the Sample Pumps as shown on the drawings and as specified in accordance with provisions of the contract documents and completely coordinated with that of all other trades.

Although such work may not be specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and compatible installation shall be furnished and installed as part of this work.

The CONTRACTOR shall furnish and install the pump(s), with all the necessary piping, controls, and appurtenances as shown on the plans and as specified herein.

2.0 – PRODUCTS

2.1 GENERAL

Each pump shall meet the hydraulic conditions and driver data as set forth in the table, “OPERATING CONDITIONS” in section 2.2 of this specification. Prior to acceptance of an equipment proposal, detailed data shall be furnished to the Engineer and shall include the following pump information:

Pump Data:	Motor Data:
Manufacturer	Manufacturer
Rated Capacity, GPM	Motor Rating, HP
Rated Head, Ft.	Full Load Speed, RPM
Speed, RPM	Type
Pump Efficiency at Rated Capacity, %	Voltage, V
Pump Horsepower at Rated Capacity, HP	Frequency, Hz
Weight of Pump, Base & Motor, Lbs.	Phase
Materials Of Construction	Weight of Motor, Lbs.

A pump performance curve showing expected performance at points other than the design conditions shall also be provided. Performance curve shall show head, capacity,

efficiency, and horsepower based on performance and shall cover the complete operating range of the pump from zero capacity to the maximum capacity. The curve is to also include a net positive suction head required curve.

Dimensional drawings of the proposed equipment shall be furnished to determine how the equipment is to be supported and if it will fit within the space available.

2.2 OPERATING CONDITIONS

The Contractor shall furnish complete pumps and appurtenances to meet the requirements specified herein or as shown on the drawing. The pumps at the indicated location shall meet the following minimum requirements:

Pump Description	Raw Water - Spring	Raw Water - River	Raw Water - Combined
Capacity, GPM	5	5	5
Total Dynamic Head, Ft.	43	43	43
Minimum Efficiency %	N/A	N/A	N/A
Max. $NPSH_R$, Ft.	N/A	N/A	N/A
Motor Size, HP	1/6	1/6	1/6
Motor Voltage/Phase/Frequency	115/1/60	115/1/60	115/1/60

2.3 SAMPLE PUMPS

The pumps shall be self-priming, metallic impeller, close coupled style. The pump body shall be constructed from cast iron. Impellers shall be constructed from cast iron or bronze, and shafts shall be stainless steel. Pumps shall be as manufactured by Gundfos Model UPS26-150, or approved equal.

2.4 MOTORS

The pump motor shall be sized to ensure the pump is non-overloading when operating on the specified pump curve. The motor shall be of the horsepower, voltage, phase and cycle as outlined herein. Motor design shall be of the totally enclosed, liquid cooled type. Motor shall be sized with a service factor of 1.15. Motor bearings shall be adequately sized to ensure long motor life.

The motor starters shall be as specified under the Electrical Division of the specifications.

A complete service report shall be made out and signed by the factory service representative and a representative of either the Owner or Engineer. Copies of the start-up report will be distributed as follows: one (1) copy each to the manufacturer's project file, consulting engineer's project file, contractor's project file and the owner's equipment file.

3.0 – EXECUTION

The sample pumps shall be installed in accordance with the manufacturer's installation and wiring instructions and as shown on the drawings.

No separate payment will be made for this item. Cost for the equipment and installation shall be included in the work to which it is subsidiary.

END OF SECTION

SECTION 11210

SUBMERSIBLE PUMPS

PART 1 – GENERAL

1.1 SCOPE

The CONTRACTOR shall furnish the equipment and services specified herein and as shown on the Drawings. The equipment to be furnished includes, but is not limited to, submersible pumps, discharge base, guide-rails, motors, motor control center, and appurtenances.

The CONTRACTOR shall also provide the services of a qualified technician (factory representative) for performing start-up, checkout and initial operation services. The technician shall have a minimum a five years experience in performing pump start-up operations. Start-up services shall include overseeing the set-up of the motor drive equipment.

1.2 MANUFACTURER

A. Quality Assurance. All pumping units shall be of approved design and make and the product of manufacturers who have built equipment of similar type, size and capacity.

B. Experience Clause. The pump manufacturer shall have a minimum of 1,000 units of similar type pumps, installed and operating for no less than five (5) years in the United States.

C. Additional Submittals. The CONTRACTOR shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

D. Replacement Parts Capability and Service. Pumping units shall be the standard, or typical, product of the pump manufacturer. The manufacturer shall produce evidence of their ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. The CONTRACTOR shall submit full details of the proposed manufacturer's ability to promptly fill replacement orders.

E. Manufacturer Information. All manufacturer information required by the specifications shall be submitted by the CONTRACTOR within twenty-one (21) calendar days of the date of receipt of the Notice of Award. Any additional information or data, specifically requested by the Engineer, shall be submitted by the CONTRACTOR within fourteen (14) calendar days of the receipt of the written

request. Approval of the manufacturer and equipment will not be given until all information required by the specifications, or requested by the Engineer, has been submitted and found acceptable.

F. Disqualification of Manufacturer. Failure to successfully comply with the provisions of the Contract, or specifications, will constitute grounds for disqualification of the pump manufacturer and SUPPLIER.

1. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, SUPPLIER, or both, unless such poor performance has been corrected.

1.3 SUBMITTALS

A. General. The CONTRACTOR shall comply with the provisions in the specifications regarding submittals, unless otherwise specified herein.

B. Content of Submittals. The following items shall be included in the submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature.
   a. Dimensions.
   b. Materials of construction (including required coatings.)
   c. Weight of pump and motor
   d. Mounting and guide-rail details

2. Performance data.
   a. Size of pump suction/discharge
   b. Flowrate, gpm
   c. Total Dynamic Head, feet
   d. Power, Brake Hp
   e. Overall pump efficiency
   f. Speed, rpm
   g. Performance curves showing overall pump efficiencies.
   h. NPSH curve (if applicable).
   i. Shutoff head.
   j. Motor data

C. Installation Information. Submit dimensional drawings containing adequate information necessary for final layout of foundations, connecting piping and valves, electrical connections, and auxiliary equipment. Drawings shall show location, size and full details of foundation or anchoring bolts.

The dimensional drawings shall outline the complete pump, drive, guide-rail assembly, and related piping and valves to be installed. The drawings shall show plan, and elevation views. The CONTRACTOR and manufacturer shall be responsible for;

1. Verifying that the equipment being proposed can be installed within the limited space of the existing structure.
2. Outline any special procedures required for removing the pumps from the wet wells, i.e. uncouple the pump from the guide rails prior to lifting the pump through the access hatch.
3. Verify that the geometry of the sump and pump submergence are acceptable for the proper operation of the pump.

D. Operation and Maintenance Manual. Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters. Three (3) bound copies of the O&M Manual shall be provided.

1.4 REFERENCES:

The pumps shall be driven by solid state starter (soft starters) as specified in Division 16.

PART 2 – EQUIPIMENT

2.1 SUBMERSIBLE PUMPS

A. Pump Design:

1. Submersible Pump(s): The pump and integrated, close-coupled motor shall be a water tight, fully submersible unit, capable of handling raw unscreened sewage, storm water, and other similar solids-laden fluids without clogging. The pump with its appurtenances and cable shall be capable of continuous submergence in the pumped liquid to a depth of 65 feet. The pump shall be as manufactured by KSB, Flygt, Wemco, or approved equal, and shall be rated for the following conditions:

	Intake Pumps
Quantity	3
Design Operating Condition	1,500 gpm @ 80 feet TDH
Minimum Shut Off Head	120 feet
Minimum Hydraulic Efficiency	80%
Minimum Motor Efficiency	95%
Maximum Speed	1160 rpm
Minimum Motor Size	50 Hp
Electrical Service	480 VAC/3ph/60hz

2. Quick Connect Guide Rail System: The discharge base elbow shall be permanently installed in the wet well and connected to the discharge piping. In order to prevent binding or separation of the pump from the guide rail system, the pump(s) shall connect to the guide rail base automatically and firmly, guided by one guide bar (two bars optional) extending from the top of the station to the discharge base elbow. The sliding guide bracket shall be a separate part of the pumping unit, capable of being attached to either standard ANSI or standard DIN pump flanges, so that the bracket is interchangeable with other pumps, and not limited to a specific pump. Non standard flange dimensions or proprietary flange designs shall not be considered acceptable. A field replaceable Nitrile rubber profile gasket or o-ring shall accomplish positive sealing of the pump flange/guide rail bracket to the discharge elbow. Metal to metal contact between the pump and discharge base elbow as a means of sealing shall not be considered acceptable. No portion of the pump shall bear directly on the floor of the sump. The guide rail system shall be available in an optional non-sparking version, approved by Factory Mutual for use in NEC Class 1, Division 1, Group C&D hazardous locations. Guide rails shall be type 304 stainless steel pipe and furnished with the pumps. Pipe schedule and bracing shall be determined by the pump manufacturer for the particular installation.

B. Pump Construction:

Major pump components shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be stainless steel 1.4401 (AISI type 316) construction. All metal surfaces coming into contact with the pumped media (other than the stainless steel components) shall be protected by a factory applied spray coating of high solids two part epoxy paint finish on the exterior of the pump. The pump shall be equipped with an open lifting hoop suitable for attachment of standard chain fittings, or for hooking from the wet well surface. The hoop shall be ductile cast iron EN-GJS-400-18 (ASTM A536; 60-40-18) and shall be rated to lift a minimum of four times the pump weight.

1. Impeller: The impeller shall be of gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B). The impeller shall be of the double shrouded, non-clogging, two vane design capable of passing a minimum of 3 inch diameter spherical solids. The impeller shall have a slip fit onto the motor shaft and drive key, and shall be securely fastened to the shaft by a stainless steel bolt which is mechanically prevented from loosening by a positively engaged ratcheting washer assembly. The head of the impeller bolt shall be effectively recessed within the impeller bore or supporting washer to prevent disruption of the flow stream and loss of hydraulic efficiency. The impeller shall be dynamically balanced to the ISO 10816 standard to provide smooth vibration free operation.

2. Wear Ring System: A replaceable wear ring system consisting of casing and impeller wear rings constructed of stainless steel shall be provided. The casing wear ring shall be stainless steel 1.4581 (AISI 318), and the impeller wear ring shall be stainless steel 1.4571 (AISI 316Ti).

3. Pump Volute: The pump volute shall be single piece gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) non-concentric design with centerline discharge. Passages shall be smooth and large enough to pass any solids which may enter the impeller. Discharge size shall be as specified on the pump performance curve. The discharge flange design shall permit attachment to standard ANSI or metric flanges/appurtenances. The discharge flange shall be drilled to accept ANSI class 125 flanged fittings. Proprietary or non standard flange dimensions shall not be considered acceptable. The suction flange shall be integrated into the volute and its bolt holes shall be drilled and threaded to accept standard ANSI class 125 flanged fittings. The minimum working pressure of the volute and pump assembly shall be 145 psi.

4. Shaft: The pump shaft and motor shaft shall be an integral, one piece unit adequately designed to meet the maximum torque required at any normal start-up condition or operating point in the system. The shaft shall have a full shutoff head design safety factor of 1.7, and the maximum shaft deflection shall not exceed .05 mm (.002 inch) at the lower seal during normal pump operation. Each shaft shall be stainless steel 1.4021 (AISI 420) material, and shall have a polished finish with accurately machined shoulders to accommodate bearings, seals and impeller. Carbon steel, chrome plated, or multi piece welded shafts shall not be considered adequate or equal.

5. Mechanical Seals: Each pump shall be equipped with a triple seal system consisting of tandem mechanical shaft seals, plus a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seal system shall consist of two totally independent seal assemblies operating in a lubricant reservoir that hydro-dynamically lubricates the lapped seal faces at a constant rate. The mechanical seals shall be of non proprietary design, and shall be manufactured by a major independent manufacturer specializing in the design and manufacture of mechanical seals. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary industrial duty solid silicon-carbide seal ring and one rotating industrial duty solid silicon-carbide seal ring. The stationary ring of the primary seal shall be installed in a seal holding plate of gray cast iron EN-GJL-250 (ASTM A-48, Class 35B). The seal holding plate shall be equipped with swirl disruption ribs to prevent abrasive material from prematurely wearing the seal plate. The upper, secondary seal unit, located between the lubricant chamber and the sensing chamber, shall contain one stationary industrial duty solid silicon-carbide seal ring, and one rotating one rotating industrial duty solid silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. A radial lip seal shall be positioned above the sensing chamber,

preventing any liquid which accumulates in the sensing chamber from entering the lower bearing and motor. The seals shall not require routine maintenance, or adjustment, and shall not be dependent on the direction of rotation for proper sealing. Each pump shall be provided with a lubricant chamber for the shaft sealing system which shall provide superior heat transfer and maximum seal cooling. The lubricant chamber shall be designed to prevent overfilling, and to provide lubricant expansion capacity. The drain and inspection plug shall have a positive anti-leak seal, and shall be easily accessible from the outside of the pump. The seal system shall not rely upon the pumped media for lubrication and shall not be damaged when the pump is run dry. Lubricant in the chamber shall be environmentally safe non toxic material.

The following seal types shall not be considered acceptable or equal: Seals of proprietary design, or seals manufactured by other than major independent seal manufacturing companies. Seals requiring set screws, pins, or other mechanical locking devices to hold the seal in place, conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces, any system requiring a pressure differential to seat the seal and ensure sealing.

6. Bearings: Each pump shaft shall rotate on permanently lubricated, greased bearings. The upper bearing shall be a cylindrical roller bearing and the lower bearings shall be a matched set of at least three heavy duty angular contact ball bearings. Bearings shall be of sufficient size and properly spaced to transfer all radial and axial loads to the pump housing and minimize shaft deflection. L-10 bearing life shall be a minimum of 100,000 hours at flows ranging from ½ of BEP flow to 1½ times BEP flow (BEP is best efficiency point). The bearings shall be manufactured by a major internationally known manufacturer of high quality bearings, and shall be stamped with the manufacturer's name and size designation on the race. Generic or unbranded bearings from other than major bearing manufacturers shall not be acceptable.

C. Motor:

The motor shall meet efficiency standards in accordance with IEC 60034-30, level IE3 and NEMA Premium. Motor rating tests shall be conducted in accordance with IEC 60034-2-1 requirements and shall be certified accurate and correct by a third party certifying agency. A certificate shall be available upon request.

The motor shall be housed in a water tight gray cast iron, EN-GJL-250 (ASTM A-48, Class 35B) enclosure capable of continuous submerged operation underwater to a depth of 20 meters (65 feet), and shall have an IP68 protection rating. The motor shall be of the squirrel-cage induction design, NEMA type B, Premium Efficiency. The copper stator windings shall be insulated with moisture resistant Class H insulation material, rated for 180°C (356°F). The stator shall be

press fitted into the stator housing. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is unacceptable. The rotor bars and short circuit rings shall be made of cast aluminum.

The motor shall be designed for continuous duty. The maximum continuous temperature of the pumped liquid shall be 40°C (104°F), and intermittently up to 50°C (122°F). The motor shall be capable of handling up to 12 evenly spaced starts per hour without overheating. The service factor (as defined by the NEMA MG1 standard) shall be 1.3. The motor shall have a voltage tolerance of +/- 10% from nominal, and a phase to phase voltage imbalance tolerance of 1%. The motor shall have a NEMA Class A temperature rise, providing cool operation under all operating conditions. The motor shall be standard FM and CSA approved for use in NEC Class I, Division I, Groups C & D hazardous locations. The surface temperature rating shall be T3C.

The motor shall be capable of operating, completely submerged, partially submerged, or un-submerged. For submerged (wet pit) applications, the motor shall be self cooling via the process fluid surrounding the motor.

1. Thermal Protection: Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140°C +/- 5°C (284°F). They shall be connected to the control panel to provide a high stator temperature shutdown signal, and are used in conjunction with external motor overload protection. In addition to the motor thermals, bi-metallic temperature switches shall be provided for the upper and lower bearings to provide high bearing temperature warning signals and pump shut down.

2. Seal Failure Early Warning System: The integrity of the mechanical seal system shall be continuously monitored during pump operation and standby time. An electrical probe shall be provided in a sensing chamber positioned above the mechanical seals for detecting the presence of water contamination within the chamber. The sensing chamber shall be air filled, and shall have a drain / inspection plug with a positive anti-leak seal which is easily accessible from the outside of the pump. A solid-state relay mounted in the pump control panel or in a separate enclosure shall send a low voltage, low amperage signal to the probe, continuously monitoring the conductivity of the liquid in the sensing chamber. If sufficient water enters the sensing chamber through the mechanical seal system, the probe shall sense the increase in conductivity and signal the solid state relay in the control panel. The relay shall then energize a warning light on the control panel, or optionally, cause the pump shut down. This system shall provide an early warning of mechanical seal leakage. Systems utilizing float switches or any other monitoring devices located in the stator housing rather than in a sensing chamber between the mechanical seals are not considered to be early warning systems, and shall not be considered equal or acceptable.

In addition to the sensor located in the seal chamber, two additional moisture sensing probes, one in the electrical connection chamber, and one in the motor chamber shall be furnished. These additional probes shall send separate signals to the control panel as described above, so that maintenance personnel are given an early warning of the presence of moisture in the respective sensing chambers. All moisture sensors shall be wired to the control panel for alarm purposes only.

3. Power Cables: The power cables shall be sized and selected according to applicable NEC, CSA, and FM standards and shall be of sufficient length to reach the junction box without requiring splices. The outer jacket of the cable shall be an oil resistant and UV stable material, and shall be capable of continuous submergence in water to a depth of 65 feet.

4. Cable Entry/Junction Chamber: The cable entry design shall not require a specific torque to insure a watertight seal. The cable entry shall consist of a cylindrical elastomer grommet, flanked by stainless steel washers. A cable cap incorporating a strain relief shall mount to the cable entry boss compressing the grommet ID to the cable while the grommet OD seals against the bore of the cable entry. The junction chamber shall be isolated and sealed from the motor by means of sealing glands. Electrical connections between the power cables and motor leads shall be made via a post type terminal board, and ring terminals, allowing easy disconnection and maintenance.

5. Lifting Bale: The pump shall be fitted with a rigid lifting bale of suitable strength to lift up to four times the weight of the pump. The lifting bale shall provide a large open loop so that the bale can be hooked from the surface, precluding the need for personnel to enter the wet well. The bale shall be designed so that standard, commercially available shackles and fittings can be used to attach lifting chains or wire rope lifting assemblies

2.2 MOTOR CONTROL CENTER (MCC)

The pump manufacturer and/or SUPPLIER shall furnish the motor control center as shown on the Drawings. The MCC shall be rated for the required horsepower, 480vac/3ph/60hz. The motor starters/drives shall be as specified under Division 16 – Electrical. The MCC shall include a terminal board for connection of the low intake level cut-off and remote pump start/stop. In addition, the following features shall be incorporated into the design of the MCC;

1. NEMA 12 lockable enclosure
2. Main Disconnect
3. Condensation heater
4. Pump Hand/Off/Auto Switch
5. Pump run time meters

6. Pump running lights
7. Motor Thermal alarm light
8. Upper bearing thermal alarm light
9. Lower bearing thermal alarm light
10. Connection chamber moisture alarm light
11. Motor chamber moisture alarm light
12. Oil chamber moisture alarm light
13. Duplex receptacle
14. Low intake water level lockout or shut-down
15. Alarm and run status relays to SCADA

SUPPLIER should note that the Drawing show a typical MCC configuration. A pump manufacturer's control panel may be utilized. The control panel shall incorporate all features specified and shown on the Drawings. The control panel equipment shall be in accordance with Division 16 specifications.

2.3 NAMEPLATES

Each piece of equipment shall be provided with a substantial nameplate, securely fastened in place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

PART 3 – EXECUTION

3.1 TIME OF DELIVERY

The CONTRACTOR shall deliver all specified equipment to the project site no later than one hundred twenty (120) consecutive calendar days after the approval of the equipment by the Engineer.

3.2 FACTORY PUMP TESTS

The pump manufacturer shall perform the following inspections and tests on each pump before shipment from factory:

1. Impeller, motor rating and electrical connections shall first be checked for compliance to the customer's purchase order.
2. A motor and cable insulation test for moisture content or insulation defects shall be made.
3. Prior to submergence, the pump shall be run dry to establish correct rotation and mechanical integrity.
4. The pump shall be run for 30 minutes submerged, a minimum of six (6) feet under water.
5. After operational test No.4, the insulation test (No.2) shall be performed again.
    a. A written report stating the foregoing steps have been done shall be supplied with each pump at the time of shipment.

3.3 MANUFACTURER' S REPRESENTATIVE

The CONTRACTOR shall furnish the services of an accredited representative of the pump manufacturer who shall review the installation and perform the start-up tests for each pump. The representative shall instruct the Owner on the operation and maintenance of the pumps. Pumping equipment shall be tested for performance according to operating curves and other approved data as soon as practical after installation. Failure of the equipment to perform in accordance to the approved operating curves shall be sufficient cause for rejection. As one condition necessary to final acceptance of any pumping unit, the CONTRACTOR shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

3.4 WARRANTY

The manufacturer shall warrant the equipment being supplied to the OWNER to be free from defects in workmanship and material, covering part and labor, for a period of sixty (60) months from the date of shipment under normal use, operation and service.

The manufacturer’s obligation under this warranty shall be to make repairs and replace parts when necessary on products that have been returned to the manufacturer’s authorized service facility with freight prepaid. Products repaired under the warranty shall be returned by the manufacturer with freight prepaid. Pump removal and installation cost are not included under the warranty.

The warranty shall be in printed form and apply to all similar units. Pro-rated and/or warranties that further reduce the manufacturer’s coverage will not be accepted.

END OF SECTION

SECTION 11211

DRY-PIT SUBMERSIBLE PUMPS

PART 1 – GENERAL

1.1 SCOPE

The CONTRACTOR shall furnish the equipment and services specified herein and as shown on the Drawings. The equipment to be furnished includes, but is not limited to, dry-pit submersible pumps, discharge base, motors, motor control center, and appurtenances as necessary for complete and operable installation.

The CONTRACTOR shall also provide the services of a qualified technician (factory representative) for performing start-up, checkout and initial operation services. The technician shall have a minimum a five years of experience in performing pump start-up operations. Start-up services shall include overseeing the set-up of the motor drive equipment.

1.2 MANUFACTURER

A. Quality Assurance: All pumping units shall be of approved design and make and the product of manufacturers who have built equipment of similar type, size and capacity.

B. Experience Clause: The pump manufacturer shall have a minimum of 1,000 units of similar type pumps, installed and operating for no less than five (5) years in the United States.

C. Additional Submittals: The CONTRACTOR shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

D. Replacement Parts Capability and Service: Pumping units shall be the standard, or typical, product of the pump manufacturer. The manufacturer shall produce evidence of their ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. The CONTRACTOR shall submit full details of the proposed manufacturer's ability to promptly fill replacement orders.

E. Manufacturer Information: All manufacturer information required by the specifications shall be submitted by the CONTRACTOR within twenty-one (21) calendar days of the date of receipt of the Notice of Award. Any additional information or data, specifically requested by the Engineer, shall be submitted by the CONTRACTOR within fourteen (14) calendar days of the receipt of the

written request. Approval of the manufacturer and equipment will not be given until all information required by the specifications, or requested by the Engineer, has been submitted and found acceptable.

F. Disqualification of Manufacturer: Failure to successfully comply with the provisions of the Contract, or specifications, will constitute grounds for disqualification of the pump manufacturer and SUPPLIER.

1. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, SUPPLIER, or both, unless such poor performance has been corrected.

1.3 SUBMITTALS

A. General: The CONTRACTOR shall comply with the provisions in the specifications regarding submittals, unless otherwise specified herein.

B. Content of Submittals: The following items shall be included in the submittals as a minimum. However, any additional information or data shall be added if and whenever requested by the Engineer. Where applicable, submit separate data for each pump.

1. Descriptive Literature.
   a. Dimensions.
   b. Materials of construction (including required coatings.)
   c. Weight of pump and motor
   d. Mounting and guide-rail details

2. Performance data.
   a. Size of pump suction/discharge
   b. Flowrate, gpm
   c. Total Dynamic Head, feet
   d. Power, Brake Hp
   e. Overall pump efficiency
   f. Speed, rpm
   g. Performance curves showing overall pump efficiencies.
   h. NPSH curve (if applicable).
   i. Shutoff head.
   j. Motor data

C. Installation Information: Submit dimensional drawings containing adequate information necessary for final layout of foundations, connecting piping and valves, electrical connections, and auxiliary equipment. Drawings shall show location, size and full details of foundation or anchoring bolts.

The dimensional drawings shall outline the complete pump, drive, guide-rail assembly, and related piping and valves to be installed. The drawings shall show plan, and elevation views. The CONTRACTOR and manufacturer shall be responsible for;

1. Verifying that the equipment being proposed can be installed within the limited space of the structure.

2. Outline any special procedures required for removing the pumps.

D. Operation and Maintenance Manual: Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters. Three (3) bound copies of the O&M Manual shall be provided.

1.4 REFERENCES:

The pumps shall be driven by solid state starter (soft starters) as specified in Division 16.

PART 2 – PRODUCTS

2.1 DRY-PIT SUBMERSIBLE PUMPS

The pump and vertical flexible coupled motor shall be capable of handling raw unscreened sewage, storm water, and other similar solids-laden fluids without clogging. The pump shall be rated for the following conditions:

	Spring Pumps
Quantity:	2
Design Operating Condition:	2,500 gpm @ 35 feet TDH
Minimum Shut Off Head:	53 feet
Minimum Hydraulic Efficiency:	80%
Minimum Motor Efficiency:	95%
Maximum Speed:	1180 rpm
Maximum Motor Size:	30 Hp
Electrical Service:	480 VAC/3ph/60hz
Minimum Free Solids Passage:	2.75 Inch Diameter
Suction Flange Diameter:	8 Inch
Discharge Flange Diameter:	8 Inch

2.2 REFERENCED STANDARDS:

1. American Iron & Steel Institute (AISI)
2. American Society for Testing and Materials (ASTM)

3. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps (HI)
4. National Electric Code(NEC)
5. International Standards Organization(ISO) - ISO9001

2.3 WARRANTY

The pump manufacturer shall warrant the pump to the Owner against defects in workmanship and materials, covering parts replacement for a period of 12 months from date of installation not to exceed 18 months from date of shipment. Pump manufacturer's warranty shall be in published form and shall apply to all similar units. A copy of the warranty shall be provided to the Owner at startup.

2.4 MANUFACTURERS

Subject to compliance with the Contract Documents, the following manufacturers are considered acceptable:

KSB, Flygt, Wemco, or approved equal

All products, whether named as "acceptable" or proposed as "equal" must fully comply with these specifications. Standard product must be modified, if required, for compliance. Materials for pump construction shall be as follows;

Pump Case:	Cast Iron, ASTM A48, Class 35B
Backplate:	Cast Iron, ASTM A48, Class 35B
Impeller:	Cast Iron, ASTM A48, Class 35B
Pump Shaft:	Stainless Steel, ASTM A276 Type 420
Bearing Bracket:	Cast Iron, ASTM A48, Class 35B
Wear Rings (casing & impeller):	Duplex Stainless Steel, AISI 329
Gaskets/seal elastomers:	NBR
Fasteners:	Stainless Steel, ASTM A276 Type 300.
Outer Seal Faces:	Silicon Carbide/Silicon Carbide
Inner Seal Faces:	Silicon Carbide/Silicon Carbide
Seal lubrication oil:	non-toxic mineral or parafin base oil

Pumps shall be capable of handling untreated wastewater containing solids of the size specified above. The pump shall be centrifugal, single stage, end suction / radial discharge type with centerline discharge. The pump shall be designed as "back pull-out" such that the entire rotating assembly can be removed without disturbing the suction and discharge connections.

2.5 INSTALLATION CONFIGURATION

The pump shall be designed for installation in a vertical position, driven directly by a vertically mounted motor through a flexible coupling.

2.6 BEARING FRAME

The bearing frame shall be heavy cast iron construction, of minimum ASTM A48 Class 35 cast iron, accurately machined to ensure permanent bearing alignment. The pump side of the frame shall form the seal oil housing. Bearings shall be permanently lubricated to provide an L10 life of, at minimum, 100,000 hours at optimum design axial and radial shaft loads.

2.7 MOTOR FRAME AND COUPLING

The drive motor shall mount on a heavy stand with the lower end machined to fit the bearing frame. The pump/motor shaft coupling shall be a standard design flexible coupling. The motor frame shall include coupling guards which, when removed, provide easy access to the flexible coupling.

2.8 MOUNTING STAND

The pump shall be mounted on a substantial fabricated base stand. The stand shall be sufficiently heavy to safely support the full installed weight of the pump and drive motor, while permitting easy access to the suction cleanout port.

2.9 SUCTION ELBOW

The pump manufacturer shall provide a 90° flanged elbow for installation between the pump suction flange and the suction piping. The elbow shall include a covered clean-out aperture with cast iron cover plug contoured to match the inside of the elbow. The cleanout shall be approximately the same diameter as the pump suction port.

2.10 DRIVE MOTOR

The drive motor shall be NEMA B design, rated for continuous duty at 40˚C, in a vertical mounted “TC” frame. The enclosure shall be TEFC (totally enclosed fan cooled) Premium Efficient. The motor shall be mounted on the motor frame at the factory to check for proper operation and alignment, then removed for shipping. Following field installation and prior to startup the installing contractor shall reinstall the motor to the frame, properly install the flexible coupling and accurately realign the motor/coupling to pump manufacturer’s specifications.

Each phase of the motor shall contain a normally closed bi-metallic temperature monitor switch imbedded in the motor windings. These thermal switches shall be connected in series and set to open at 140^{o}C +/- 5^{o}C. They shall be connected to the control panel to provide a high stator temperature shutdown signal, and are used in conjunction with external motor overload protection. In addition to the motor thermals, bi-metallic temperature switches shall be provided for the upper and lower bearings to provide high bearing temperature warning signals and pump shut down.

2.11 MAJOR COMPONENTS

Furnish major components (pump case, impeller, backplate, and bearing bracket) of cast material as specified with smooth surfaces devoid of blow holes and other irregularities.

2.12 PROTECTIVE COATING

All pump components shall be cleaned to SSPC-SP10 (near white) and coated with a ferric oxide primer. Shop-applied surface finish shall be a 2-component epoxy resin base coating with a solids content >82%. Motors, couplings and other components not manufactured by the pump supplier shall be supplied with the component manufacturer's standard surface finish.

2.13 CLEAN-OUT PORT

All pumps with discharge size of 4" or larger shall include a minimum 4-5/8" diameter clean out aperture cast into the pump case near the cut-water. The clean out aperture cover shall be cast of the same material as the pump case and shall extend completely through the pump case with an inside contour to match the case. The cover shall fasten to a flange cast onto the pump case and shall be sealed with an o-ring. Fabricated (non-cast) cover plates, covers not contoured to match the casing, or covers with flat gasket seals will not be considered as acceptable.

2.14 AUXILIARY CONNECTION PORTS

Threaded ports with hex head plugs and sealing gaskets shall be supplied for pressure gauge (near discharge flange), venting (at high point of pump case), casing drain (at low point of pump case), and seal leakage drain (at low point of bearing frame).

2.15 IMPELLER

The impeller shall be statically and dynamically balanced, capable of passing the minimum solid size specified above. Back vanes shall be provided to minimize axial loads and to propel solids away from the seal area. The impeller type deemed most suitable for this application is:

KSB TYPE K - Closed solids handling multi-vane impeller, double shrouded with 2 or 3 contoured fluid channels designed for high efficiency pumping of industrial and municipal wastewater.

2.16 SHAFT

The pump shaft shall be of sufficient size to transmit full driver output with a maximum deflection of 0.002 inches measured at the outer mechanical seal. The entire pump shaft shall be machined of ASTM A276 Type 420 stainless steel material.

2.17 SHAFT SEAL

Provide two totally independent mechanical shaft seals, installed in tandem, each with its own independent single spring system acting in a common direction. The driver-side seal shall operate in an integral oil-filled chamber with drain and inspection plug for easy access from external to the pump. The impeller-side seal shall operate in a large flooded chamber formed by cast recesses in the impeller and backplate. Both seal interfaces shall be lubricated by the seal chamber oil, allowing for extended periods of dry-running operation without the need for external seal lubrication or cooling systems. Conventional double mechanical seals with single or multiple springs acting in opposed direction are not acceptable unless provided with an approved seal pressurization system which maintains seal oil pressure at a minimum of 1.5 times the pump's maximum shut-off head. Cartridge-type mechanical seals, or seals with face materials other than silicon-carbide, will not be considered as acceptable for this application.

2.18 EQUIPMENT TESTS

Tests shall be performed in accordance with the Test Code for Centrifugal Pumps per the Standards of the Hydraulic Institute. Tests shall be performed on the actual assembled pumps by the pump manufacturer to be supplied. Tests shall cover a range from shut-off to at minimum 20% beyond specified design capacity. Conduct test per above specification on all supplied pumps, generating a curve showing actual flow, head, BHP and hydraulic efficiency.

2.19 VERIFICATION OF PERFORMANCE

The contractor shall field test all pumps after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation or over-heating. Any pump which fails to meet any of the contract specifications will be modified, repaired or replaced by the contractor at no additional cost to the owner.

PART 3 – EXECUTION

1.1 TIME OF DELIVERY

The CONTRACTOR shall deliver all specified equipment to the project site no later than one hundred twenty (120) consecutive calendar days after the approval of the equipment by the Engineer.

1.2 MANUFACTURER' S REPRESENTATIVE

The CONTRACTOR shall furnish the services of an accredited representative of the pump manufacturer who shall review the installation and perform the start-up tests for each pump. The representative shall instruct the Owner on the operation and maintenance of the pumps. Pumping equipment shall be tested for performance

according to operating curves and other approved data as soon as practical after installation. Failure of the equipment to perform in accordance to the approved operating curves shall be sufficient cause for rejection. As one condition necessary to final acceptance of any pumping unit, the CONTRACTOR shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

1.3 WARRANTY

The manufacturer shall warrant the equipment being supplied to the OWNER to be free from defects in workmanship and material, covering part and labor, for a period of sixty (60) months from the date of shipment under normal use, operation and service.

The manufacturer's obligation under this warranty shall be to make repairs and replace parts when necessary on products that have been returned to the manufacturer's authorized service facility with freight prepaid. Products repaired under the warranty shall be returned by the manufacturer with freight prepaid. Pump removal and installation cost are not included under the warranty.

The warranty shall be in printed form and apply to all similar units. Pro-rated and/or warranties that further reduce the manufacturer's coverage will not be accepted.

END OF SECTION

SECTION 11214

VERTICAL TURBINE PUMPS WITH VARIABLE FREQUENCY DRIVES

1.0 GENERAL

Furnish all labor, materials, equipment and services for manufacturing, assembling, delivering, installing, testing and placing in service all pumping equipment including pumps, motors, bases and appurtenances.

The Contractor shall also provide the services of a qualified start-up technician (factory representative) who has had prior on-site experience to assist in performing start-up, check-out and initial operation services as well as aid in installation of the pumping equipment. The lump sum price for this item shall also include the services of a factory representative of the pump manufacturer during start-up. These services shall be provided as long as so deemed by the Engineer.

Unless otherwise specified, the pump manufacturer shall furnish each pumping unit complete with drive motor and all other components, and shall be held entirely responsible for the compatibility in all respects of all components furnished. No flexible pipe material will be accepted.

Pumping units shall be as specified herein and shown on the Drawings.

Design conditions and characteristics of all pumps to be furnished under this contract are included in the specific pump section of this specification.

2.0 DEFINITIONS

When the term "pumping unit" is used it shall be deemed to mean a pump or pumps, complete with, but not limited to, drive motor, controls, accessories, appurtenances and all associated equipment.

3.0 CONTRACT DRAWINGS

The contract drawings are intended to show a general arrangement of pump equipment, drives, structural supports, foundations, connected piping and valves.

The pump suction and discharge nozzles shown shall be considered minimum sizes unless otherwise specified.

4.0 MANUFACTURER

4.1 QUALITY ASSURANCE

All pumping units shall be of a proven design and make and products of manufacturers who have built equipment of similar type, size and capacity.

4.2 ADDITIONAL SUBMITTALS

The Contractor shall submit, upon request, any additional information that the Engineer may deem necessary to determine the ability of the proposed manufacturer to produce the specified equipment.

4.3 REPLACEMENT PARTS CAPABILITY AND SERVICE

Pumping units shall be the products of manufacturers who can produce evidence of their ability to promptly furnish any and all interchangeable replacement parts as may be needed at any time within the expected life of the pumps. The manufacturer shall have a fully staffed factory trained service center within eight (8) hours of the installation.

4.4 MANUFACTURER INFORMATION

The Contractor shall submit all manufacturer information required by the specifications.

Approval of the manufacturer or supplier will not be given until all information required by the specifications has been submitted.

4.5 DISQUALIFICATION OF MANUFACTURER

A. Failure to successfully comply with the provisions of sub-paragraphs 4.1 through 4.4, shall constitute grounds for disqualification of the pump manufacturer.

B. Poor performance of similar pumping equipment now in operation under the specified conditions of service and pump rating constitute grounds for disqualification of the pump manufacturer, supplier, or both, unless such poor performance has been corrected.

5.0 SUBMITTALS

5.1 GENERAL

The Contractor shall comply with the provisions in the specifications regarding submittals, unless otherwise specified herein.

5.2 CONTENT OF SUBMITTALS

The following shall be included in submittals as a minimum. Where applicable, submit separate data for each pump.

A. Descriptive Literature
   a. Dimensional Drawings
   b. Materials of construction (including required coatings)
   c. Performance data
      1. Size of pump.
      2. GPM.
      3. TDH.
      4. BHP.
      5. Overall pump efficiency (inlet through discharge head.)
      6. RPM.
      7. Performance curves showing overall pump efficiencies.
      8. NPSH curve (if applicable).
      9. Shutoff head.
      10. Weight of pump.
      11. Head.
      12. Rated HP of motor.
      13. Weight of motor.

5.4 INSTALLATION INFORMATION

Submit drawings and information necessary for final design of foundations, connecting piping, valves, pump drip and drainage piping, electrical connections, starting, speed regulating and protective equipment, and auxiliary equipment. Drawings shall show location, size and full details of foundation bolts.

For all pumping units, a cross-sectional drawing of the assembled pump showing details and materials of construction shall be submitted for approval.

5.5 MAINTENANCE AND OPERATIONS MANUAL

Manual shall contain all information necessary for proper operation and maintenance of pumping units, as well as the location of the nearest permanent service headquarters. Three (3) bound copies of the pump operation and maintenance manual shall be provided.

6.0 MANUFACTURER'S REPRESENTATIVE

The Contractor shall furnish the services of accredited representatives of the pump manufacturer who shall supervise the installation, adjustment, and testing of each pumping unit and give instructions to operating personnel. Pumping equipment shall be tested for performance according to curves and other approved data as soon as

practical after installation. Failure of the equipment to perform as curves indicate and with other approved data shall be sufficient cause for rejection. As one condition necessary to acceptance of any pumping unit, the Contractor shall submit a certificate from the manufacturer, stating that the installation of the pumping unit is satisfactory, that the unit is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit.

7.0 EQUIPMENT

7.1 HIGH SERVICE PUMPS

A. General

The Contractor shall furnish, install and place in operation three (3) vertical turbine pumps with suction barrels. Motor starters and controls shall be included in Electrical and Instrumentation work. Pumps being driven by Variable Frequency Drives (VFDs) shall have the drives furnished by the pump supplier and drives shall comply with the specifications in this section.

B. Discharge Head

The pumps shall be supplied with a fabricated steel, flange mounted “L-head” discharge head. Each pump shall have a suction barrel flanged with 150 lbs. ANSI drilling. The centerline of the suction barrel shall be located in a vertical plane, in a perfectly plumb position, 90 degrees from the horizontal centerline of the discharge flange rated at 300 psi working water pressure. The base of the discharge head shall be machined to match the drilling of the suction barrel flange. The top diameter of the discharge head shall match the diameter of the motor base to assure uniform distribution of load.

The suction barrel and discharge nozzle sizes shall be as shown on the contract drawings.

The discharge head base shall be of sufficient size to span an opening of such dimensions that shall permit removal of the complete pump unit connected below. Two lifting lugs shall be provided with capacity to support the weight of the entire pump.

Pump shall be supplied with a fabricated steel base plate of sufficient size to span the opening. All hardware for securing the base plate shall be supplied by the pump manufacturer. Steel plates with pertinent data shall be attached to the pump.

C. Stuffing Box

Pump stuffing box shall be of the bleed line type, through bore design. Stuffing box shall be made of cast iron bolted to the discharge head. A split

type gland retains four (4) rings of packing and a lantern ring. The stuffing box bearing below the packing shall be leaded bronze 1104 material. The stuffing box shall be of sufficient size to accommodate a flanged adjustable spacer coupling designed for easy impeller adjustment and seal removal without disturbing the motor. Seal materials shall be suitable for the pumped liquid.

D. Pump Bowls

Pump bowls shall have rabbet fits for alignment and be flanged and bolted type made of close-grained cast iron. The bowls shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or one and one-half times shutoff head, whichever is greater.

Pump bowls shall be equipped with replacement wear rings and shall be enameled for improvement in efficiency. A belled suction of cast iron shall be provided to reduce entrance losses to a minimum and shall have a high lead bronze 1104 bearing, packed with non-water soluble grease and positioned in a housing supported by four (4) vanes. A sand collar shall be positioned above the bearing and rotate with the shaft.

E. Impellers

The impellers shall be of bronze conforming to ASTM B584 C83600, of the enclosed type and statically and dynamically balanced. They shall be securely fastened to the impeller shaft with tapered split collets or lock nuts. The impellers shall be adjustable vertically by means of the flanged adjustable spacer coupling.

F. Pump Shaft

The pump impeller shaft is to be turned and polished stainless steel having a chromium content of not less than 12% conforming to ASTM Type- 1655. It shall be supported by bearings above and below each impeller. The suction case bearing is to be bronze and grease lubricated. Intermediate bowl bearings are to be lubricated by the water being pumped and shall be of bronze. The size of the shaft shall be ample to transmit the horsepower required by the pump with minimum deflection. Renewable wear rings shall be furnished on the casing and the impeller. Matting wear surfaces of harden materials shall have a difference in Brinell Hardness number of at least 50, unless both the stationary and rotating wear surfaces have Brinell Hardness numbers of at least 400. Renewable wear rings shall be held in place by a press fit with locking pins or threaded dowels.

G. Lineshaft

The line shafts shall be turned and polished carbon steel of a size that conforms to the requirements of ANSI Standard Specifications for Deep Well

Vertical Turbine Pumps, Number B58.1. The shaft shall be furnished in interchangeable sections having a nominal length of not over 5 feet. The butting faces shall be machined square to the axis of the shaft. The line shafts shall be coupled with a steel couplings designed with a safety factor of one and one-half times the shaft safety factor and shall have a left hand thread to tighten during pump operation. The shaft shall be provided with a non-corrosive sleeve of 316 stainless steel at the location of each guide bearing. The section of shaft passing through the stuffing box shall be stainless steel having a chromium content of not less than 12%.

H. Lineshaft Bearings

The bearings shall be designed for vertical turbine pump service to be lubricated by the liquid being pumped. They shall be mounted in bearing retainers which shall be held in position in the column couplings by means of the butted ends of the column pipes. The bearings shall be spaced at intervals of not more than 10 feet (5 foot on pumps operating at speeds in excess of 2200 RPM).

I. Discharge Column Pipe

Column pipe size shall be such that the friction loss will not exceed 5 feet per 100 feet based on the rated capacity of the pump. The pipe shall be furnished in interchangeable sections having a nominal length of 5 feet; and shall be connected by flange type couplings.

J. Suction Barrel

A suction barrel shall be furnished for each vertical turbine pump and sized for a maximum of 3.0 ft. per sec. velocity at the maximum flow condition. The suction barrel or well shall be constructed of D.I. pipe and fittings, and shall be provided with a suitable flange to support the entire pumping unit and connect to the discharge head. The barrel shall be of sufficient inside diameter to provide clearance for the pumped fluid without pump cavitation. A 3/4” NPT tap with corporation cock shall be provided at the top of the suction barrel to allow the purge of air from the suction barrel.

K. Pump Motor

Contractor shall furnish motors and motor starters with the pump and shall be designed for the conditions listed this specification. The motors shall be the premium, high efficiency type. Motors shall have adequate capacity to drive the pump continuously under the head specified without overloading the nameplate rating of the motor at any point on the performance curve from shut-off head to full capacity. The nameplate ratings shall be standard catalog rating with the manufacturer; no special motors will be considered.

Motor shall be of the reduced voltage starting vertical hollow shaft, squirrel cage induction type and shall be equipped with non-reverse ratchet and comply with applicable ASA Specifications. Motor shall have NEMA weather protected Type

1 enclosure and Class B insulated (epoxy sealed). Motors shall be designed for 60 degrees C. rise (40 degrees C. ambient). Motors shall be designed for 460/3/60.

The high service pump motors shall be of the high-thrust design type. Thrust bearings of ample capacity to carry the weight of all rotating parts plus the hydraulic thrust shall be incorporated into the motor as an integral part of it. Motor thrust bearings shall be grease lubricated with grease fittings, and grease flushing outlet and shall have AFBMA minimum life rating of five years based on the maximum thrust at any possible operating condition.

L. Quietness of Operation

The pump and motor shall operate at the specified capacities in the range of heads specified without undue noise and vibration. Any undue noise in the pump, which is objectionable in the opinion of the Owner or Engineer will be sufficient cause for rejection of the units. Pump noise and vibration shall be within the limits and standards established by the Hydraulic Institute.

M. Operating Conditions

The project will contain three (3) high service vertical turbine pumps. Pumps shall be equal to Peerless or Fairbanks-Morris. Motors shall be U.S. Motors, G.E., Westinghouse or equal.

1. Three (3) High Service Pumps shall be capable of delivering the fluid medium at the following conditions:

Shut-Off: 0 GPM: @ 729 feet TDH
Design: 775 GPM: @ 495 feet TDH
Minimum Efficiency at Design Flow: 82.0%

Secondary: 900 GPM: @ 468 feet TDH
Minimum Efficiency at Secondary flow shall be 80.0%

NPSH requirements shall not exceed 20 feet at design flow.

The pump driver shall be a high efficiency, vertical A.C. induction motor, open drip-proof construction, normal thrust type and shall be 125 Hp, 1770 rpm and suitable for 3 phase, 60 hertz, 480 volt electrical service. The motor shall be operated through a Variable Frequency Drive (VFD).

13.0 MISCELLANEOUS

Nameplates and other labels shall be stainless steel, suitably secured to the pump. Parts shall be completely identified with a numerical system to facilitate parts inventory control. A separate number shall properly identify each part, and those parts, which are identical, shall have the same number to effect minimum spare parts inventory.

14.0 EXECUTION

Installation and Operating Instructions

Installation of the pump systems shall be done in accordance with the written instructions provided by the manufacturer. Operation and maintenance manuals shall be furnished which will include parts list of components and complete service procedures and troubleshooting guide.

Field Start-Up

The Contractor shall include in his bid the services of a factory trained representative for whatever period of time, assuming 1 trip, is required to inspect, start-up, test the control system, and instruct plant personnel in the proper maintenance and operation of such equipment. The owner of this equipment shall supply any personnel to assist the factory start-up crew which are required to oversee or perform actual work if so required by labor/credit contracts. This cost shall be born by the Contractor. Prior to final approval, the manufacturer shall submit a letter certifying that the installation has been tested, and functions as per the plans and specifications. The manufacturer shall provide the services of a factory-trained representative for a maximum period of one day on-site per station to perform initial start-up and to instruct the owner's operating personnel in the operation and maintenance of the equipment.

The manufacturer or the manufacturer's authorized distributor must provide start-up services which will include: voltage check; amp check; installation check; rotation check; and draw down tests to establish pump capacity. A written report to the engineer must be submitted after start-up.

Payment

No separate payment will be made for this item. The cost shall be included in the work to which it is subsidiary.

END OF SECTION

SECTION 11220

VERTICAL PADDLE FLOCCULATORS

PART 1 – GENERAL

1.1 WORK INCLUDED

A. The contractor shall furnish and install two (2) Vertical Paddle Flocculators in flocculation basins, as shown on drawings.

B. There will be two (2) Flocculation Basins each approximately 18’-0” x 18’-0” x 9’-8” deep. Each tank will have one (1) vertical flocculator. Each Vertical Paddle Flocculator shall consist of a motor with variable speed gear reducer, vertical drive shaft, paddle reel, fiberglass paddles, lower steady guide and anchorage.

1.2 QUALITY ASSURANCE

A. ACCEPTABLE MANUFACTURERS

1. The flocculator mechanisms and associated equipment shall be furnished by a single manufacturer who is reputable, qualified, and has a minimum of ten (10) years of experience in the manufacturing of the equipment to be furnished. Any bidder not listed shall provide documentation permitting the owner or owner's representative to evaluate the proposed equipment. Such documentation shall include design criteria, specifications, drawings and a listing of 10 installations with owner/operator's name and telephone number for each installation.

1.3 DESIGN CRITERIA

A. The Flocculator components shall comply with the following design criteria:

1. Velocity Gradient “G” value: 875
2. Tip speed: 3.0 fps maximum
3. Mean Water Temperature: 60°F
4. Design Flow: 694 gpm
5. Detention Time: 33 minutes @ design flow

1.4 MANUFACTURER’S REPRESENTATIVE FOR START-UP AND TESTING

A. The services of the Manufacturer's technical representative shall be provided for startup installation checks and training of Owner's operating personnel, troubleshooting and other services. At a minimum, service shall be for one (1) site visit for two (2) days. If additional service is needed it shall be to the contractor's

expense. Representative shall furnish a certificate of installation after each visit stating the equipment is ready for operation.

PART 2 – PRODUCTS

2.1 DRIVE UNIT

A. The drive unit shall consist of a motor and a variable speed gear reducer. Each motor shall be integrally mounted with a suitable speed-changing device, which shall provide, through manual adjustment, an infinite selection of peripheral speeds equal to a 4:1 ratio.

B. The totally enclosed motor shall be 230/460 volt, 3 phase, 60 hertz and not less than; 1st Stage - 3.0 HP, 2nd Stage – 3.0 HP, and be suitable for outdoor operation.

C. The variable speed device shall be of the friction disc type and shall be directly connected to a gear reduction unit fully housed with all moving parts immersed in oil and equipped with anti-friction bearings throughout.

2.2 DRIVE SHAFT

A. The drive shaft shall be cold drawn C1018 solid steel shaft sufficiently strong to support the paddle reel and transmit the required torque of the drive.

B. The upper end of the drive shaft shall be directly connected to the output shaft of the speed reducer by means of a rigid coupling, which shall be keyed and pinned to the shafts. The lower end of the drive shaft shall turn in a water lubricated steady guide securely fastened to the tank floor.

2.3 PADDLE REELS

A. Each paddle reel assembly shall consist of angle arms connected to the central drive shaft through 1/2" thick steel gusset plates welded to the shaft. The arms shall be fabricated from 2-1/2" x 2-1/2" x 1/4" thick steel angles and shall be bolted to the gusset plates for paddle supports. Each pair of angle arms shall be stiffened with a structural steel angle brace bolted between them. Each reel assembly shall be furnished with 4 arms with 4 vertical paddles on each arm. Manufacturer shall provide calculations showing determination of velocity gradient or “G” value.

B. The paddles shall be 6" wide fiberglass channels. Paddles shall be fastened to the angle arms by means of stainless steel bolts and locknuts. Paddles shall be the length shown on the plans but not less than 2 ft. less than the water depth.

2.4 LOWER STEADY GUIDE

A. If required, manufacturer shall provide a water lubricated cast iron or steel steady guide with a UHMW sleeve and a fabricated steel support for alignment of the drive shaft.

2.5 GENERAL ITEMS

A. The equipment manufacturer shall furnish all 316 stainless steel field assembly and anchor bolts, nuts and washers for the equipment furnished by him.

B. The General Contractor shall place the anchorage in accordance with certified prints supplied by the equipment manufacturer.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with the Manufacturer's instructions and recommendations. Contractor shall also furnish the oil and grease for initial operation. The grades of oil and grease shall be in compliance with the Manufacturer's recommendations.

3.2 PAINTING

A. With the exception of the drive unit and paddles, all steel work shall be prepped per SSPC-SP-6 and given one shop coat of Tnemec 66 Series 20 Pota-Pox epoxy primer 3.0 to 6.0 mils. DFT, color to be selected by owner.

3.3 ELECTRICAL CONTROLS

A. The General Contractor shall furnish and install all field wiring required including correct size wire, conduit fittings and supports.

B. All electrical controls such as start/stop push button stations shall be furnished by and installed by the General Contractor.

END OF SECTION

SECTION 11225

TUBE SETTLER SYSTEM

1.0 GENERAL

1.1 SCOPE OF WORK

A. Installation of tube settler modules, effluent orifice pipe, and necessary support system as shown on drawings and as specified herein.

1.2 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials
B. NSF International – Standard 61
C. AISC Code of Standard Practice
D. AWS D 1.1 Structural Welding Code

1.3 SYSTEM DESCRIPTION

A. Definitions:
1. Tube Settler Module – Tube settlers are comprised of multiple tubular channels sloped at an angle of 60°, which allow enhanced settling characteristics and accumulation of solids within a settling basin. Module shall be 2'-0" in height and cover the areas indicated on the Drawings.
2. Support System – Structural system designed to support tube settlers as required. Support system shall be designed and furnished by the tube settler manufacturer.
3. Effluent Collector Pipe – Fiberglass Effluent pipe shall be designed and furnished by the tube settler manufacturer. The layout of the collection pipes shall be as shown on the Drawings.

B. Description of System:
1. System includes tube settler modules, effluent collector pipes, and support structures.

C. Interface with Adjacent System(s):
1. Install tube settler system within clarifier as directed on project drawings.

D. Tolerances:
1. Top of adjacent tube modules shall be installed true level, plus or minus 1/2 inch in full length.
2. A maximum 1/4 inch space is allowed between installed modules.

E. Performance Requirements:

1. Each tube shall have a cross sectional perimeter of approximately 10.0 inches to give a low Reynolds number and of an approximate triangular shape that allows rapid accumulation, concentration, and drainage of solids.
2. Cross corrugation of tubes with mixing points within individual modules is not allowed. This causes mixing currents, which adversely affect the settlement of solids as well as re-suspend the settled solids within the system.
3. Reversal of tube direction between adjacent modules is not allowed. Such reversal causes mixing currents at the surface of the module as described above.
4. Protective surface grating shall not impact performance of tube settlers or cause physical damage to tube settler material.

1.4 QUALITY ASSURANCE

A. Qualifications of Manufacturer:

1. Tube settler module manufacturer shall have minimum 5 years continuous experience in manufacture and supply of tube settlers.

B. Installation Requirements:

1. Install tube settler system in accordance with manufacturer's written instructions.
2. Tube settler system manufacturer provides services of qualified representative onsite to provide instructions on installation, cutting, etc.

C. Source Quality Control:

1. Certification of tube modules as complying with ANSI/NSF-Standard 61 for use in potable water.
2. Individual modules will bear the seal as being NSF Certified.
3. All equipment to use potable grade material suitable for use in drinking water plants.

1.5 SUBMITTALS

A. Shop drawings required for following:

1. Tube Settler Modules
2. Support Structure for modules
3. Fiberglass Effluent Collector Pipes
4. Supports for effluent pipes

B. Product Data required as follows:

1. Tube Settler Module
    a. Materials
    b. Installation instructions

2. Support Structure
    a. Materials
    b. Installation instructions

3. Effluent Collector Pipes
    a. Materials
    b. Installation instructions

C. Operating and Maintenance (O&M) Instructions:
1. O & M Instructions shall include:
    a. Storage and installation procedures
    b. Cleaning procedures

D. Certificates:
1. Provide certificate that tube settler modules are Tested and Certified by NSF to ANSI/NSF Standard 61 Drinking Water System Components.

1.6 DELIVERY, STORAGE & HANDLING

A. Delivery
1. Tube modules shall be shipped and delivered to job site on pallets.

B. Storage
1. All material and equipment shall be shipped, stored, handled, and installed in such a manner as to not degrade quality or serviceability.
2. The tube settling modules shall not be stacked more than four high (8 ft.) (One over the other).
3. All modules shall be stacked such that the PVC sheet planes are in a vertical position (similar to the manner of their placement inside the tank).
4. A light colored cover shall cover all modules required to be stored in the open beyond two months. Ideally these covers should be double sided such as a white on black. The white side, facing out, is used to reflect light away. Clear covers are prohibited. Black is not recommended. Black will absorb heat and if the cover comes in direct contact with the media, this heat can be quickly transferred to the media.
5. Covers can not be wrapped tightly around the media. There should be at least a 6" air gap between the cover and top of media. The ends of the cover should be securely anchored on all sides with at least a 12" air gap at the bottom. These covers should provide shading while allowing air to pass through to prevent heat from building up.
6. Modules should be checked at least once a week. It is very possible that the covers can become loose over time due to wind or rain. A check of the stored area should be done to make any minor repairs to the cover or to restack any modules that could have fallen.

C. Handling

1. Tube modules shall remain on shipping pallets until ready to install.
2. Any abusive handling of the modules shall not be permitted. Workmen shall be careful in placing the tube modules and avoid any damage to the corners and tube edges.
3. Personnel shall not stand or walk directly on top of the modules, except as outlined in Section 2.1 A. 5.
4. Media modules may get brittle at low temperatures or soft at high temperatures. Therefore, care should be used in the handling of modules.

2.0 PRODUCTS

2.1. MATERIALS

A. Tube Module:

1. The material of construction shall be flame resistant, self-extinguishing, rigid PVC.
2. Material shall be inert and resistant to naturally occurring constituents in water and to the normal dosage of water treatment chemicals required in the treatment process.
3. Tube settler module must be Tested and Certified by NSF to ANSI/NSF Standard 61 Drinking Water System Components. Evidence of certification must be included with submittal package and indelibly marked on the sheets of the modules.
4. The PVC sheet shall be prime, rigid PVC conforming to commercial standard ASTM D1784:12454B with the following properties:

Property	Test Method	Unit	Typical Value
Specific Gravity	D792	gm / cu.cm	1.45max.
Tensile Strength	D638 / D882	psi	6,000 min.
Flexural Modulus	D790	psi	425,000 min.
Flexural Strength	D790	psi	11,000 min.
Elastic Modulus	D638 / D882	psi	360,000 min.
Impact Resistance	D4226	in. lbs. / mil	1.2 min.
Heat Deflection	D648	°F (264 psi)	162 min.
Flammability	D635		self-extinguishing < 5 sec.

5. The module shall be self supporting and of structural integrity adequate to support foot traffic, such foot traffic may occur only on the surface of a 4’ X 4’ x 3/8" thick plywood sheet placed on the modules to prevent any damage to the tube edges.
6. Structural integrity of the modules shall be maintained under a loading of 15 pounds per sq. ft. which includes the module dead weight plus a

uniformly distributed residual solids load of 10 pounds per sq. ft while bearing a movable live load of 250 lbs concentrated over a one sq. ft. area

B. Support System:

1. The support system shall be constructed of stainless steel as designed and provided by the maker of the tube settlers.

2. The support structure shall be designed to support 200 lbs. per lineal foot, or a concentrated load of 250 lbs. placed anywhere on the structure. The maximum deflection of the structure under full live load shall be 1/240 of the span.

C. Effluent Orifice Pipes:

1. Shall be constructed of fiberglass reinforced plastic (FRP).
2. Pipes shall be 12” diameter.
3. Pipes shall be fabricated to ANSI/AWWA standards F101 and NSF 61.
4. 1-1/4” Orifice holes shall be drilled in the pipe. Orifices shall be located and spaced per the Orifice Pipe Detail contained within the drawings.
6. Pipe supports shall be designed and furnished by the tube settler system manufacturer.

D. Welding materials:

1. In accordance with AWS specifications.
2. Compatible with materials being welded.

2.2 FABRICATION

A. Tube Module:

1. All PVC sheets shall be thermoformed and have a continuous, dedicated glue guide to allow precise alignment of sheets during assembly and installation. Non-thermoformed sheets, which do not provide dedicated guides for precise tube alignment, are not acceptable.

2. Fabricated modules shall be comprised of tube-like channels sloped at an angle of about 60° placed in same direction to prevent mixing points and unstable flow patterns. Modules consisting of tubes in alternating directions are not acceptable.

3. The settling tube length (consistent with efficient solids separation) shall not be less than 27 inches

4. Rectangular or square shape tubes or "cross-flow" tube settlers shall not be acceptable.

5. Join PVC sheets and channels by solvent bonding to provide a rigid structure, resistant to separation of sheets.

B. Structural steel for tube module supports:

1. Fabricate all structural steel components as shown on the drawings and to comply with AISC Code of Standard Practice.

2. Accurately cut and mill ends of members to provide neat appearance and to provide full contact of surfaces prior to welding and joining.
3. Camber horizontal members to accommodate dead load deflection.
4. Fabricate items with joints neatly fitted and secured.
5. Grind exposed welds smooth and flush with adjacent surfaces.
6. Where mechanically fastened, make exposed joints flush butt type hair line joints.
7. Where mechanical fastening in field, provide slotted holes.
8. Supply components necessary for complete anchorage and fastening of metal fabrications.
9. Fit and shop assemble as appropriate for delivery to site.

3.0 EXECUTION

3.1 PREPARATION

A. Field measurements:
1. Field verify all dimensions affecting installation.
2. Layout all work prior to installation.

B. Protection:
1. Protect adjacent surfaces, piping and other items.
2. Protect tube settler material as outlined in Section 1.6 B.

3.2 INSTALLATION

A. Approval for installation or incorporation in this project will be made only after submittal of shop drawings or other data as specified herein.

B. The tube settler modules shall be installed in accordance with manufacturer's recommendations.

3.3 WARRANTY

A. Tube settler system shall be guaranteed to be free from defects in material for a period of 1 year from date of Substantial Completion by Owner.

END OF SECTION

SECTION 11240

CHEMICAL FEED EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Under this item the Contractor shall furnish all materials, labor, equipment and services required for a complete and operating chemical feed system as specified herein and as shown on the Drawings.

B. The Contractor shall furnish and install, as needed, electrical connections, control wiring, water supply lines, solution lines, drains, overflows, vents and all associated piping and appurtenances to each feeder.

C. The Contractor shall install wiring from the Main Control Panel (MCP) to all chemical feeders for automatic on/off operation. Each feeder shall have a local Hand/Off/Auto switch at its respective starter or control panel. In the “Auto” mode the equipment shall start/stop based on the process flow through the water plant.

D. Corporation stop solution diffusers shall be provided for each chemical being fed into a pipe. For chemicals being fed into a basin or tank, the solution pipe shall terminate at the center of the pipe entering into the basin.

E. Unless otherwise shown on the drawings or specified, all chemical feed lines from metering pumps shall be Sch. 80 PVC with solvent welded fittings. Isolation valves, back-pressure valves, pressure relief valves, and other similar appurtenances shall be PVC true-union type. Drains, vents, and gravity feed lines shall be constructed from Sch. 80 PVC.

F. All components, accessories, and appurtenances shall be compatible for use with the specified chemical in which it is being used.

1.2 CHEMICAL FEED SYSTEMS

A. Liquid Chemical Feed System(s) shall be furnished and installed for the following chemical(s): Fluosilicic Acid, Poly Aluminum Chloride (PACL)

B. Chemical Scale(s) shall be furnished for the following chemical(s): Fluosilicic Acid

C. Day Storage Tank(s) shall be furnished for the following chemical(s):
Fluosilicic Acid

D. Chemical Transfer Pump(s) shall be furnished for the following chemical(s): Fluosilicic Acid

1.3 SHOP DRAWINGS

A. Shop drawings, catalog cut sheets, descriptive data shall be submitted for approval. Shop drawings shall include:

1. Dimensional data for each feeder system
2. Typical installation data
3. Wiring diagrams
4. List of materials of construction

1.4 OPERATION and MAINTENANCE MANUALS

A. Two (2) Operations and Maintenance Manuals shall be furnished to the engineer for each type of chemical feed equipment.

PART 2 – PRODUCT

2.1 PERISTALTIC METERING PUMPS **– NOT REQUIRED ON THIS PROJECT**

A. Description

1. Pumps shall be positive displacement type, complete with replaceable cartridge-style peristaltic pump head technology and self-contained variable speed drive as specified.

2. Pumps shall be self-priming, and shall have a maximum suction lift capability of up to 30' vertical water column.

3. Discharge Pressure Rating: 145 psi intermittent, 100 psi continuous.

4. Pumps shall be capable of pumping both liquids and gases without vapor locking.

5. Pump shall not require the use of internal or external check valves, back pressure valves, suction foot valves, strainers, pulsation dampeners, or auto degassing valves and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components during operation.

B. Quality Assurance

1. These specifications are the basis for design for the listed chemical metering pumps. All pumps, whether named as an acceptable supplier or submitted as an equal must, at a minimum, meet the following critical design requirements.

2. Pump shall be 24 hour continuous duty rated and have a three-year manufacturer's warranty from date of shipment.

3. For quality assurance, pumps must be supplied and labeled by the original manufacturer. Relabeled products, even under license by manufacturer, shall not be acceptable.

4. Manufacturer must have a minimum twenty (20) years of experience manufacturing peristaltic pumps, must have a direct business presence in the United States for minimum of twenty (20) years, and must employ a minimum of fifty (50) employees in the United States. Manufacturers without a direct American presence who distribute through a third party distributor are not acceptable.

5. Pumps must be manufactured in compliance with ISO 9001-2008 standards.

6. Pumps shall be meet CE, NSF 61 and applicable electrical standards.

7. To ensure proper function and quality, pump head, tubing, and drive must be manufactured by the same company.

C. Submittals

1. Submit the following
    a. Certified shop drawings.
    b. Characteristic performance curve showing flow rate as a function of RPM and pressure.
    c. Dimensional drawings.
    d. Operating, maintenance, programming, and wiring instructions
    e. Manufacturer’s certification that pump head and drive are all manufactured by the same manufacturer.

D. Manufacturers

The following named manufacturers are considered acceptable:

1. Watson-Marlow
2. Lutz-Jesco
3. Prominent
4. Or approved equal

E. Peristaltic Metering Pump Schedule:

CHEMICAL	
Treatment Use	
Primary Inject. Point	
Number Required	
Max. Capacity (gph)	

F. Pump Construction

1. Pump head
   a. Provide tool-free cartridge-style peristaltic pump head technology. Pumps that require special tools for tube replacement, cleaning, rebuilding or routine maintenance are unacceptable.

   b. Max rating: 2 GPH at 100 rpm

   c. Housing Construction: corrosion resistant and high impact resistant glass filled PPS.

   d. Geometry: Pump head shall consist of sealed track housing with in-line porting. Suction and discharge ports shall be 180 degrees apart with bottom suction and top discharge.

   e. Rotor: Pump head rotor shall be constructed of glass filled Nylon, sealed within the track housing, and supported by its own bearings. Peristaltic occlusion level shall be factory set to ensure flow accuracy of +/- 1% and repeatability performance of +/- 0.5% and shall not require any field adjustment.

   f. No-valve design: Pump shall require no internal or external check or degassing valves. At all times the rotor shall provide compression of the peristaltic element.

   g. Contact Materials: All pump head components in the fluid path must be NSF61 listed and shall be of materials specified by the manufacturer as compatible with the process fluid.

   h. Leak Containment/Detection: In the event of peristaltic element failure, the leak sensor shall shut the pump down immediately with all process fluid contained within the sealed pump head.
      1) Sensor Type: Utilize non-contacting optical sensor. Sensor shall not come in contact with the process fluid, shall contain no moving parts, shall not depend on the capacitance of the process fluid, shall

not require fluid to leak out of the pump housing for engagement, nor shall require any sensitivity or calibration adjustment.
2) Alarm: Sensor shall shut down the pump, give a visual indication on the drive controller, and if specified shall provide an output general alarm signal.
3) For operator and environmental safety, pumps which do not have leak containment, leak sensor, and shutdown are not acceptable. For additional overpressure safety, sealed pump head shall have a controlled drain-to-waste port.

i. Port connections: Pump head shall utilize polypropylene compression fittings which shall mate to 10mm ID reinforced, transparent PVC interface hose. Provide polypropylene compression by ½" NPT adaptors for connecting interface hose to process line.

j. Spares: Provide one (1) spare pump head per pump supplied.

2. Drive
   a. Rating: Continuous 24 hour operation, 45° C ambient.

   b. Voltage: Drive shall be suitable for 100-240VAC, 50-60Hz, 1-Phase with an internal switch-mode power supply. Supply ten-foot length main power cord with standard 115VAC three-prong plug.

   c. Max drive power consumption: 190VA.

   d. Enclosure: NEMA 4X constructed out of corrosion and impact resistant engineering plastic, 20% Glass filled PPE/PS. By nature of the environmental conditions, painted or unpainted metallic housing including 316SS are not acceptable. Enclosure shall house the drive motor and all control circuitry in one integrated unit. Separate VFDs and motors are not acceptable.

   e. Direct coupled pump head with fully protected drive
      1) Pump head shall direct couple mount to the controller via a splined drive shaft and shall be locked in place by two tool-free thumbscrews.
      2) Pump head shall be fully sealed to prevent any contamination of the controller or drive shaft by process fluid.
      3) Pump head shall contain its own rotor bearings and not impart an overhung load on the pump shaft.
      4) Pump heads shall be supplied mounted to the left or right side of the drive enclosure as specified in the drawings. If not specified, pump heads shall mount to right side of the enclosure.
      5) Drive shall stop shaft rotation and give visual alarm in the event the pump head is removed.

f. Drive motor: brushless DC motor with integral gearbox and closed loop tachometer feedback.
   1) Circuitry complete with temperature and load compensation and protection.

3. Manual Control Interface
   a. Flow range: 7,900:1 flow range from 0.001-2.0 GPH in 0.001 GPH increments.

   b. Display: Backlit graphical TFT Display capable of up to 8 lines of text with up to 26 characters per line to display pump tag number, flow rate, and programming instructions. Display shall also provide visual indication of running status via screen color: Blue = Running, White = Stopped, and Red = Warning.

   c. Keypad: Keypad for start, stop, speed increment, speed decrement, rapid prime, and programming.

   d. Flow units: Programmable in either ml/min or gallons/hour.

   e. Security: Programmable keypad lock and PIN security for optional lockout of all keys except emergency start/stop.

   f. Auto Restart: feature to resume pump status in the event of power outage interruption.

   g. Fluid level monitor: Programmable flow totalization to notify operator when the supply tank is low.

   h. Minimum requirements: Pumps that do not meet the minimum manual control requirements as specified above are not acceptable.

4. Installation and Training
   a. Contractor shall install items in accordance with manufacturer's printed instructions and as indicated and specified.

   b. A qualified representative of the metering pump shall provide two (2) eight hour training days on the use and operation of the pump. The training events shall be coordinated and scheduled with the Owner.

2.2 MECHANICALLY ACTUATED DIAPHRAGM METERING PUMP

1. Mechanically Actuated Diaphragm Metering Pump
   a. Each pump shall be complete with TEFC motor 110 volt, manual stroke length adjustment and integral Microprocessor based pump control.

Parts coming into contact with the liquid shall be selected to ensure optimum corrosion resistance against the liquid being pumped.

2. Metering pump shall be of the mechanically actuated diaphragm type. An eccentric mechanism shall convert the rotary motion of the motor shaft to reciprocating push rod motion through a worm gear arrangement. The worm gear arrangement shall have all wearing parts immersed in oil for lubrication to reduce wear. Lubrication shall not require the recirculation of oil by an auxiliary pump. Each pump shall include an oil dipstick. The eccentric mechanism shall drive the diaphragm push rod, which is mechanically attached to the diaphragm. Forward motion of the push rod and the attached diaphragm shall produce the discharge stroke and a spring shall return the push rod to produce the suction stroke. The maximum stroking rate shall be 140 strokes per minute.

3. Dial operated manual stroke length adjustment shall provide positive repeatable settings for capacity adjustment over a 10:1 range while the pump is operating. The stroke adjustment dial shall have a locking mechanism.

4. The metered liquid shall enter the metering head at the bottom and exit at the top through ball type check valves. These valves shall be gravity seating or spring-loaded type with valve seats and shall be guided to accurately control vertical and sideways motion of the ball. Primed pumps shall have a minimum suction lift capability of 10 feet of water. Liquid head connections shall be screwed union type to eliminate clamping bars and other metal parts subject to corrosion. Plastic parts shall be molded and stress relieved for strength.

5. The molded elastomer diaphragm shall be Teflon coated. A back-up plate shall support the diaphragm. Flat, unsupported diaphragms, diaphragms subject to severe stretching, and pistons unprotected or in contact with the feed solution shall not be acceptable. Pumps shall have an isolation chamber formed by a hypalon splash deflector located behind the diaphragm to protect the pump body in case of diaphragm leakage. This chamber shall have a drainage port that may be directed back to the tank or fitted with a leakage probe with a contact that can turn the pump off or initiate an alarm.

6. The pump housing shall be aluminum and protected by a two part epoxy coating. The worm and gear type speed reducer shall be fully enclosed within the housing. The high-speed shaft shall have ball bearings. There shall be an oil seal at the push rod extension to permit diaphragm replacement without draining the lubricating oil.

7. Each motor shall be driven by a flange-mounted c-face motor capable of a minimum 320:1 turndown ratio when the metering pump is equipped with a microprocessor control.

8. Each metering pump shall be equipped with a microprocessor control, which provides local and remote speed frequency control via a local pressure sensitive keypad or from a remote pulse, 4-20mA or 0-20mA process signal. The controller shall be powered by 120 volts, single phase, 60 Hertz. The controller shall be pre-wired and include a 6 foot long power cable with a standard 3 prong plug. The pump controller shall be housed in a NEMA 4X protected enclosure and be mounted on the pump by the factory, opposite the liquid end. The controller shall be equipped with a self-diagnostic package, such that it carries out a "self check" which switches off the pump if no stroke has been carried out two seconds after startup of the motor, or the stroke sensor has malfunctioned. The Microprocessor controller shall include, but not limited to, the following: adjustable maximum and minimum speed frequency, local and remote interface for both ON/OFF, speed frequency programming in "INTERNAL" mode or by remote 4-20mA, 0-20 mA input signal in "EXTERNAL", Pulse contact Multiplication and Division control, Green "POWER ON" indication light, Green "EXTERNAL" indication light, and "RED" alarm indication light. The controller shall be capable of stable operation over an ambient temperature range of 50 degrees F. to 104 degrees F. Other features provided by the control are: input signal greater than 20mA, input signal less than 4mA, pump SPM, overpressure or stroke error, and current programmed mode of operation. Messages for the above failures will be displayed locally on the LCD display. Motor speed control by VFD or SCR will not be accepted.

Mechanically Actuated Diaphragm Metering Pump Schedule:

CHEMICAL	Liquid Alum	Hydrofluosilicic Acid, 25%
Treatment Use	Coagulant	Dental Health
Injection Point	Flash Mix	Filter Effluent
Number Required	2	1
Max. Capacity (GPH)	30	2.0
Head Arrangement	Simplex	Simplex
Back Pressure (psi)	50	50
Stroke Length Control	Manual	Manual
Motor Speed Control	Yes	Yes
Motor HP – Voltage	1/3 - 110	1/3 - 110

2.3 SCALES

A. General

1. The scale shall be comprised of a low profile floor mount weighing base and a remote mount electronic indicator, furnished complete with 15 ft. interconnection cable. Electronic Platform Scale suitable for weighing drums, carboys, or tanks as outlined in the schedule.

B. Manufacturer: Provide chemical scales as manufactured by the following;

1. Eagle Microsystems, Inc.
2. Force Flow
3. Or approved equal

C. Components

1. Scale Base: The weighing platform shall be constructed from non-corrosive, high impact, solid PVC plastic, and shall be covered by a 5 year warranty. The scale base dimensions shall be no less than indicated in the schedule. The platform shall be supported by four precision, sealed, strain gage, beam-type load cells with shock isolating, adjustable-height leveling feet. Load cells shall be temperature compensated 0-150 F. Systems incorporating hydraulic load cells and fewer than four load cells shall not be acceptable. All scale electronics, including the load cell, shall be fully sealed for maximum protection against a hostile chemical environment. The safe load of the scale shall be 120% of the capacity.

2. Electronic Indicator: The electronic indicator shall provide a 6-digit, high intensity, LED digital display of "Gross", "Tare", "Remaining", "Used" and "Total" weights. A vertical LED array shall clearly indicate status of the weight display. A "Low Level" visual indicator shall be furnished as standard. Optional low level alarm contacts shall also be provided. The instrument shall have an electronic tare weight adjustment of 0-100%. Display resolution shall be user selectable in 0.2, 0.5, or 1 lb. increments. The instrument shall have an isolated output of 4-20 mA into 400 ohms.

3. Power Supply: The scale shall operate from a 120 Vac, 60 Hz power supply.

4. Accuracy: Scale accuracy shall be 0.1% full scale capacity.

Warranty: The entire scale shall be covered by the manufacturers Standard Warranty, which shall include the entire assembly for one (1) year from date of startup. The scale base shall be protected by an extended warranty for a minimum of five (5) years, which will provide warranty repair or replacement if the scale base is damaged through corrosive exposure.

5. Chemical Scale Schedule:

CHEMICAL	Base Size (inches)	Capacity (lbs.)
Hydrofluosilicic Acid, 25% (Fluoride)	24 x 24	1,000

2.4 DAY TANKS

A. General: The Day Tank shall be constructed from cross linked high density polyethylene. The tanks shall be installed at the locations shown on the drawings and as outlined in the schedule. Bulkhead fittings required for pipe connections shall be furnished and installed by the tank manufacturer. The Contractor shall vent each day tank separately to the exterior of the building.

B. Cross-Linked High Density Polyethylene (XLPE) Tanks: The day tanks shall be rotationally molded from cross-linked high density polyethylene. The tanks shall be the vertical, cylindrical, flat bottom, dome top, and seamless construction type. Tanks shall be designed using a 600 psi hoop stress at 73 degrees F and a specific gravity rating of 1.9, and shall comply with ASTM D1998-Standard Specification for Polyethylene Upright Storage Tanks. The manufacturer shall be responsible for furnishing tanks and accessories that are chemically compatible with the material being stored.

C. Accessories: Each tank shall be furnished with a threaded access and cover on the lid, and pipe connections of the size(s) indicated in the schedule. Drains and/or bottom outlets shall be integrally molded into the body of the tank, requiring no interior tank access for pipe connections. Drains shall be located as close as possible to the bottom of the tank and equipped with isolating ball valves. Vent and fill line connections shall be located on the tank's top and installed using bulkhead fittings. The Engineer shall verify orientation of all connections during the submittal process. Each tank shall be furnished with graduated marks reflecting the volume in gallons. Graduation markings shall be molded into the tank.

D. Cross-Linked High Density Polyethylene Day Tank Schedule:

CHEMICAL	Hydrofluosilicic Acid, 25%
Capacity (gal)	55
Diameter (inches)	20
Height (inches)	38
Threaded Cap (in.)	8
Side Gallon Marker	Yes
Fill (inches)	1
Vent (inches)	1
Drain (inches)	None

2.5 CHEMICAL TRANSFER PUMPS

A. General

1. Chemical Transfer Pumps shall be furnished and installed at the locations shown on the drawings.

2. The pump shall be constructed from materials that are compatible with the chemical being transferred.

3. The Contractor shall be responsible for installing the pump, piping, and accessories required.

4. Rigid piping shall be Sch.80 PVC. Flexible tubing shall be clear PCV reinforced with polyester braid and rated for a minimum pressure of 100 psi.

B. Magnet Drive Centrifugal Pump

1. Pumps shall be the plastic seal-less magnet drive horizontal centrifugal type. The pump shall be constructed from carbon-filled polyvinylidene fluoride (PVDF). The pump's impeller shall be magnetically coupled to the drive motor. The impeller magnet shall be totally encapsulated within the impeller. Pumps shall be as manufactured by Finished Thompson, Inc., DB Series centrifugal pumps, or equal.

C. Accessories and Piping

1. The Chemical Transfer Pumps will be used to move chemicals from the bulk storage tanks to the day tanks. The Contractor shall be responsible for installing the pump, piping, and accessories required. The piping shall be Sch.80 PVC. A loop on the discharge side of the pump shall extend up to an elevation equal to the bulk storage tanks lid to prevent siphoning through the pump. The PVC check valve and ball valve shall be installed on the discharge side of the pump. A ball valve shall also be installed on the suction side. Unless otherwise shown on the drawings, the minimum size of the piping shall be the same as the pump suction size.

D. Chemical Transfer Pumps Schedule:

CHEMICAL	Hydrofluosilicic Acid, 25%
Type	Centrifugal
Material	PVDF
Capacity (gpm)	30
Head (feet)	40
Horsepower (Hp)	< 1
Voltage/Phase	115v/1ph
Suction (Inches)	1
Discharge (inches)	1

PART 3 – EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed in accordance to the manufacturer's recommendations.

3.2 START-UP and MANUFACTURER'S SERVICES

A. Start-up, field testing, inspection, etc. shall be performed by a technician trained and/or certified by the equipment manufacturer.

B. Two (2) day trips, each 8 hours, shall be scheduled for training on the chemical feed equipment. The training shall be coordinated and scheduled with the Owner.

END OF SECTION

SECTION 11500

AIR BURST SYSTEM

1.0 GENERAL

1.1 SCOPE

A. This section of the specifications covers the furnishing and installation of the Air Burst System and appurtenances as shown on the drawings and specified herein.

B. The following items are a part of the Air Burst System and shall be furnished by one manufacturer to ensure a properly designed and integrated system.
   1. Air Burst System for removing debris from the surface of the intake screens.

1.2 QUALITY ASSURANCE

A. The entire air burst system shall be furnished by a single manufacturer who shall comply with the following:
   1. The equipment manufacturer must maintain an ongoing quality assurance program, including ISO-9000 certification.
   2. The single manufacturer supplying this equipment must be able to furnish proof of over 25 installations of similar designs which have been in successful operation for a minimum of three years.

2.0 PRODUCTS

2.1 GENERAL

A. All system components and equipment utilized in the air burst system shall be furnished as a complete integrated system by one manufacturer.

3.0 AIR BURST SYSTEM

3.1 GENERAL

A. The contractor shall provide an automatic air burst system designed to remove debris from the screen surface by delivering a suitable volume of compressed air to the inside of the screen body. The air shall scour the screen surface to maintain adequate design flow and through slot velocity characteristics.

3.2 PRODUCTS

A. The air burst system shall consist of an integrated system of duplex compressors, receiver tank, automatic control panel, solenoid valves, heat tracing, and associated accessories. The system shall be designed for exterior use with temperatures ranging -20 degrees to 120 degrees Fahrenheit.

1. Compressor(s) – Each compressor shall be 10 Hp, 2 stage, reciprocating style with a minimum rating of 60 cfm @ 175 psi. Compressor and motor shall be rated for continuous duty. Each compressor shall be sized to recharge the receiver tank to 175 psi within 15 minutes. Duplex compressors are required. Electrical service shall be 460v/3ph/60 Hz. The duplex compressors shall be mounted on top the receiving tank.

2. Primary Receiver Tank – The receiver tank shall be an ASME certified vessel with a minimum volume of 120 gallons. The manufacturer shall verify that the tank volume is adequately sized to displace the system piping volume plus three (3) screen volumes of air during an air burst cleaning.

3. Secondary Receiver Tank – A second receiver tank shall be provided and installed for the operation of the water level sensors. The tank shall be an ASME certified vessel with a minimum volume of 5 gallons, and rated for 175 psi minimum.

4. Automatic Control System shall include the following features;
    a) NEMA 12 Control Panel
    b) Main panel disconnect
    c) Electrical service shall be 460v/3ph/60 Hz.
    d) Electrical disconnect for each compressor
    e) Compressor motor starters
    f) Automatic alternation of compressors. Each compressor to be operated through a local H/O/A switch on the Control Panel.
    g) Automatic primary receiver tank drain valve operation
    h) Heat tracing with thermostat control for the primary receiver tank's drain valve
    i) General Controls Description
        i. The Control Panel shall be equipped with an Off/On/Remote selector switch.
        ii. In the "Off" position, the Air Burst System will not be operable.
        iii. In the "On" position, the Air Burst cycle, or frequency, shall be controlled by a local cycle timer. Timer shall be adjustable from 0.25 to 24.00 hours.
        iv. In the "Remote" Position, the control panel shall receive a closed contact signal from the plant's operators to begin the Air Burst cycle.
        v. Each time an Air Burst is initiated, the system shall automatically cycle through all the screens starting with the air burst header located below the screen(s), followed by the upstream screen and proceeding in order downstream.

vi. Changing the switch from “Off” to “On” will immediately start a screen burst cycle provided the pressure tank is recharged.

vii. Placing the switch in the “Off” position shall reset the Cycle Timer to the beginning cycle time, i.e. time = 0.

5. Solenoid Valves & Control Piping – Control piping and valves shall be 2” NPT, 316 stainless steel.
   a) Valves shall be 2-piece body style with female NPT end connections and rated for 1,000 psi.
   b) Actuators shall be two position electric style with anodized and epoxy coated aluminum housing. Valves and actuators to be as manufactured by W.E. Anderson, Dwyer Instrument Series WE01-HTD02-A or approved equal.

6. Accessories
   a) The air compressor shall be furnished with vibration isolation pads installed under each support leg or frame connection to the concrete base. Install per compressor manufacturer’s recommendation.
   b) Flexible hose shall be installed between the compressor and the solenoid valve manifold to prevent the vibration from transferring to the pipe. The flexible hose shall be 2” NPT, braided 316 stainless steel and rated for 300 psi.
   c) Variable area flow meters shall be provided as indicated on the plans. Variable area meters shall be as manufactured by Brooks Instrument Company, SHO-RATE Model 1250A.

3.3 SUBMITTALS AND MANUALS

A. Submittals shall include dimensional and operating data for all the equipment and components. Where manufacturer’s catalogs are used for submittals, the specific item being submitted shall be clearly identified. Wiring diagrams and control schematics shall be included with the submittal.

B. Three (3) copies of the Operation & Maintenance (O&M) Manuals shall be provided.

END OF SECTION

SECTION 11900

WATER DISTRIBUTION SCADA SYSTEM

1.0 GENERAL

1.1 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete Supervisory Control and Data Acquisition (SCADA) System FOR THE Owner's Water Distribution System.

B. The SCADA system shall consist of two sub-systems: a web-based user interface and the Remote Terminal Units (RTU's) of various sizes.

C. The SCADA system shall be manufactured by High Tide Technologies, SCADATA, MISSION, or approved equal.

1.2 GENERAL

A. The web-based user interface software shall provide all the functions necessary for the Owner to interact with the data from the remote units as well as execute configuration and control commands.

B. The Manufacturer shall have available several models of RTU's which will accommodate a wide variety of Input and Output (I/O) requirements. RTU's shall be furnished and installed at each of the monitored sites as shown on the drawings and included below:

1. Thirteen (13) – Water Tank Remote Units
2. Twelve (12) – Water Pump Station Remote Units
3. Eight (8) – Water Flow Meter Remote Units
4. One (1) – Water Treatment Plant Interface (Personal Computer)
5. One (1) – Water Treatment Plant Interface to High Service Pumps – shall include a minimum of four (4) analog inputs programmable for any water tank level in the distribution system.

1.3 QUALIFICATIONS

A. The SCADA System shall be furnished by a single supplier/system integrator who shall assume responsibility for providing a complete and integrated system.

B. Manufacturers Qualifications: Only manufacturers who have been regularly engaged in the supply of SCADA equipment for at least 10 years and capable of meeting the following criteria need respond.

1. Have completed a minimum of five (5) satellite telemetry systems and five (5) cellular telemetry systems.
2. Provide the Owner with reference names and phone numbers for a minimum of five Satellite Telemetry System customers and five Cellular Telemetry system customers.
3. Acknowledge that shipment of the SCADA RTU units and related equipment shall be authorized only by the Owner.
4. Utilize only UL listed and rated components in enclosure manufacture.
5. Provide all hardware and software technical manuals to the Owner in digital portable document format (PDF). Three (3) hard copy O&M manuals shall also be furnished.
6. Provide a complete bill-of-materials (BOM) and enclosure layouts that are numerically cross-referenced together for each SCADA unit. The BOM shall contain the standard factory supplied part numbers instead of proprietary numbers.
7. Provide a warranty and customer support for a period of not less than two (2) years after the Owner accepts each SCADA unit.
8. Provide primary technical support to the Owner by full-time qualified staff members only.

C. Installer Qualifications:

1. Only installers who have been regularly engaged in the installation of SCADA equipment and have completed the Manufacturer's installer certification course need respond.

1.4 SPARES

A. The SCADA system supplier shall provide one (1) spare unit for each unique piece of hardware furnished.

2.0 PRODUCTS

2.1 WEB-BASED USER INTERFACE SOFTWARE

A. Compatibility: The system shall be compatible with modern web browsers on Windows, iOS, and Android operating systems including computer, tablet and smartphone platforms.

B. Access and Security: Access to the customer's user interface shall begin with a username and password screen. The web interface shall utilize fully encrypted data and passwords via standard HTTPS technology – the same level of security used by online banking applications. The person designated by the Owner as the "administrator" shall have authority to manage usernames and passwords as well as control and change certain parameters related to their system.

C. Levels of Access: Four levels of access shall be provided. VIEWERS shall only have permission to view the system data. OPERATORS shall be able to view and acknowledge alarms. SUPERVISORS shall be able to perform all the functions of the operators as well as change parameters in the system and manually turn pumps on and off. ADMINISTRATORS shall be able to perform all the functions of the supervisors as well as create and delete users from the system. Administrators shall also be able to assign which contacts will receive alarms.

D. User Limits: The Owner shall be able to create as many users as needed and all users shall be able to be logged in simultaneously. No additional charge shall be assessed on the number of users or viewers.

E. User Interface Types:

1. The system shall provide options to the Owner for either tabular or graphical status representations of the installations.
2. Large systems shall be able to be broken down into segments or zones for easy navigation and display. Size, location and layout of objects on the screen shall be customizable by the software provider upon Owner request.
3. The software shall be capable of showing locations and status of each RTU installation on maps, given Owner supplied addresses or coordinates.

F. The system shall have robust Alarming Capabilities, including the following features:

1. The ability to send alarms via voice calls, text messages or emails.
2. The ability to configure a preferred alarm delivery order with delays between each level and each operator.
3. The ability to accept acknowledgments via voice or text at the time the alarm is delivered or via the web interface at any time.
4. The ability for users to view a list of alarms histories for each installation including which user acknowledged the alarm.
5. The ability to set any alarm recipient to be “Nagged” by calling them every 10 minutes until someone acknowledges the alarm.
6. The ability to set shifts and days off for each alarm recipient and set day and night shift alarm notifications.
7. The ability to have audible and visual alarms pop-up on the computer that is logged in to the system.
8. The ability to alarm the user if the RTU has stopped communicating with the host servers.

G. Auto Refresh: The web interface shall automatically refresh when new data or alarms are reported.

H. Data Analytics and Graphing: The system shall provide various menus to allow users to view historical data on pop-up graphs. Users shall have the ability to set the time range of the graphs and zoom in to view events of the past. When a user's mouse is held over a data point, the details of that point shall appear on the screen.

I. Raw Data Downloads: The user shall be able to dump raw data in tabular format for offline analysis that can be imported into a spreadsheet for further analysis.

J. Report Generation: The user shall have the ability to download formatted spreadsheet reports of various functions. The software shall also provide the ability to automatically fill in the owner's report forms in standard Excel formatted files.

K. Screen Configuration: The Manufacturer shall provide a service to configure graphic and tabular screen layouts, particular locations and sizes of graphical objects to match the customer's requirements.

L. Service History: The system shall provide a mechanism for the user to enter freeform service history information for all RTU sites.

M. The system shall be capable of providing Automatic and Manual Controls as listed below:

1. Ability for Tanks to control one or more remotely located pump stations and valves based on tank level or system pressures. This should be performed in either "round-robin" or "lead-lag" type configurations.
2. Ability to automatically cause the digital input from one RTU to be replicated on the digital output of another RTU (when digital outputs are available).
3. Ability to automatically cause the analog input level at one RTU to be replicated on the analog output of another RTU (when analog outputs are available).
4. Ability for the user to set analog threshold alarms and controls and have them downloaded to the RTU. These include levels, pressures, flow rates and any physical sensor that outputs an analog signal. This feature shall apply to RTU's with analog input capability.
5. Ability for supervisors or administrators to manually control digital outputs that are connected to valves or pumps on RTU's that are equipped with outputs.

2.2 REMOTE TERMINAL UNITS (RTU)

A. General: RTU's shall be AC or Solar powered depending on the model, as designated by the Owner. The RTU's shall be available as either a kit that can be mounted in existing cabinets or supplied in a NEMA 4X enclosure with a raised door supported by stainless steel hinges on the left and a stainless steel latch configured for a padlock (supplied by Owner). The electronic components provided shall be din-rail mounted for easy replacement without removal of the enclosure. AC power supplies and solar regulators shall be modular and easily replaceable in

the field. (Excluding HTT300 that is provided in an IP67 Polycarbonate enclosure) System shall be rated for full sunlight exposure, and shall be suitable for temperature conditions between -20°F to 104°F, at a minimum.

B. The Manufacturer shall have the following types of RTU's available, or an equivalent substitute:

RTU Model	Digital Inputs	Analog Inputs	Digital Outputs	Analog Outputs	Operating Network
HTT300	4	1	-	-	Satellite, Cellular
HTT900	12	-	-	-	Satellite, Cellular, IP
HTT1100	8	4 Included (8 Optional)	4 Optional	-	Satellite, Cellular, IP
HTT3100	28	6 Included (10 Optional)	4	2	Satellite, Cellular, IP
HTT4100	28+	12+	8	Optional	Cellular, IP

1. Solar power shall be available for HTT300 and HTT1100 models.
   a. Solar power options shall include 10W, 20W, 60W, and 120W power systems. Final configuration shall be chosen based on the application and external I/O drain requirements.
   b. Batteries for each of the solar power options shall also be sized appropriately between 10Ah and 180Ah capacity.

2. Back-up battery power shall be available for all but HTT4100 in the event that AC power is lost. When in battery backup mode the unit shall, at a minimum, have enough power to send out a power fail alarm, and on some models maintain functionality for up to two (2) days.

C. The Manufacturer shall have the following types of Inputs and Outputs available:

1. Digital inputs compatible with either open collector or dry contact sources. Optional 115V or 230V instrumentation relays to mount in the enclosures when required.
2. Counter inputs. Four of the digital inputs configurable as pulse counters for flow monitoring equipment or rain gauges.
3. Analog inputs configurable to accept either 0-5V or 4-20ma and 0-20ma inputs. For 4-20ma and 0-20ma inputs, the sense resistor shall be 250ohms and removable for voltage sensors. 4-20ma inputs configurable to accept 2-wire, 3-wire or 4-wire sensors. Battery backed up 24V loop power shall also be available as well as analog inputs with optional integrated surge protection available.
4. Digital Outputs. RTU's with digital outputs configured with din-rail mounted Form-C relays capable of switching up to 5A at 250V.

5. Analog Outputs. RTU's with analog outputs capable of syncing 4-20ma outputs under RTU control.
6. Modbus Master. At least one type RTU shall have an RS-232 port that can be configured as a Modbus Master for reading data from third-party PLC or sensor equipment.

D. Two-Way Communications: The RTU shall have capability to both send alarms and scheduled reports up to the server as well as receive commands from the server at any time. All functional configurations and alarm thresholds shall be able to be sent from the server without visiting the RTU.

E. Digital Alarm Functions: The RTU shall be able to report status changes or alarms on any digital input. All analog inputs may be configurable as digital or alarm inputs.

1. Pseudo alarms shall be available to report when two or more selected digital inputs are in the alarm state at the same time.
2. Whenever a digital alarm occurs the status shall be reported to the server after a programmable validation delay.

F. The RTU shall have the following Analog Input Monitoring Functions:

1. Reports analog input levels on programmable schedules ranging from 1 min to several hours.
2. Ability of the user to configure up to four separate alarm thresholds for each analog input. The RTU shall send an extra report to the server whenever the analog level passes through any of the alarm thresholds. Alarm thresholds shall be continuously monitored regardless of the reporting interval.
3. Ability to configure the RTU to sample the analog input only when one or more digital inputs are active. This may be used to monitor pump amps or flow rate only when a pump is running.
4. Ability to report an alarm when an analog reading falls too rapidly such as tank level falling due to system leak.

G. Local Pump Controller: The RTU shall include a software pump controller with the following functions built in and configurable over the communications channel:

1. Local control for up to three (3) pumps.
2. Local alternation, lead-lag, or round-robin control behavior.
3. A "maximum number of pumps running" setting that actively turns off pumps to stay below the maximum.
4. Back up timers that can be set for maximum "PUMP ON" time or maximum "PUMP OFF" time or both. The maximum "on" setting shall have the ability to be configured to turn all pumps off, or to force alternation.
5. Ability to set a time of day where the RTU turns pumps on for a fixed duration of time.

6. Alarm the server if a pump is called for but does not start.
7. Ability to turn a pump on or off based on local analog input alarm thresholds. This can be used for functions like low suction cut-off, local altitude valve control or local alarm light activation

H. Flow Meter Functions. The RTU shall support the following features associated with flow meters:

1. Four (4) internal 32-bit pulse counters stored in non-volatile memory.
2. Ability to report the counter totals on intervals ranging from 1 minute to once per day.
3. Ability to convert two (2) of the counter inputs pulse rates to a flow rate and report to the server in the form of an instantaneous flow rate reading.
4. Ability to take two (2) of the Analog inputs connected to flow rate outputs of meters and integrate the signal to create a pseudo totalizer simulating a pulse counter. This will be used when pulse outputs are not available from the flow meters.

I. Power Monitoring. The RTU shall support the following power related functions:

1. All units shall have battery backup that keeps the core functions active for at least two (2) days. Depending on what option is installed, some I/O's will continue to function normally.
2. Alarms shall be sent to the server when power loss is detected.
3. For solar RTU's or AC powered RTU's running on battery, alarms shall be sent to the server when the battery reaches a critical low level. Solar units shall also report if no charging voltage is received after a period of 4 days, as an indication that the panel may be defective.

SCADA System Schedule – Water Storage Tanks

Distribution Site	Latitude, °	Longitude,°	Parameter to Monitor
Toohey Ridge Tank	37.13474	-85.98130	1
Hatcher Valley Tank	37.16968	-84.05913	1
Northtown Tank	37.20198	-84.03673	1
Pine Ridge Tank	37.32305	-84.09282	1
Mt. Sherman Tank	37.44899	-84.35532	1
Echo Tank	37.03106	-84.27153	1
Knob Lick Tank	37.09071	-84.29861	1
Node Tank	37.14735	-84.35150	1
Hiseville Tank	37.12649	-84.18664	1
Monroe Tank	37.23034	-84.29668	1
Magnolia Tank	37.41648	-84.24367	1
Horse Cave Tank	37.18318	-84.08374	1
New Horse Cave Tank	37.16114	-84.09843	1

SCADA System Schedule – Booster Pump Stations

Distribution Site	Latitude, °	Longitude,°	Parameter to Monitor
Cave City	37.13454	-84.00476	3,4,5,6
Hatcher Valley	37.18723	-84.07823	3,4,5,6
Northtown	37.21798	-84.03085	3,4,5,6
Munfordville	37.29236	-84.09525	3,4,5,6
Magnolia	37.44710	-84.26343	3,4,5,6
Wisdom	37.07445	-84.29303	3,4,5,6
Hiseville	37.08864	-84.20351	3,4,5,6
Three Springs	37.17574	-84.26264	3,4,5,6
Crail Hope	37.15952	-84.33106	3,4,5,6
Bearwallow	37.15105	-84.14086	3,4,5,6
Jeffries	37.28175	-84.28454	3,4,5,6
Bunnell Crossing	37.22170	-84.18754	3,4,5,6

SCADA System Schedule – Master Meters

Distribution Site	Latitude, °	Longitude,°	Parameter to Monitor
Larue Co. – Barren Run	37.44907	-84.20504	2
Larue Co. – Magnolia	37.45471	-84.25736	2
Larue Co. – HWY 1192	37.47346	-84.32690	2
Green Co. – Monroe	37.22588	-84.32105	2
Bonnieville – 6 Inch	37.37084	-84.09639	2
Bonnieville – 3 Inch	37.39527	-84.09881	2
Munfordville – 6 Inch	37.26735	-84.11783	2
Munfordville – Akebono	37.29333	-84.09436	2

Parameter to Monitor Legend

1. Water Level, Ft. of Water
2. Flowrate, gallons per minute
3. Pump No. 1 Call-to-Run
4. Pump No. 2 Call-to-Run
5. Suction Pressure, psi
6. Discharge Pressure, psi

J. Ease of Replacement. Main electronics' modules shall have the following features:

1. Main electronic modules shall be din-rail mounted for easy removal and replacement. (Excluding HTT300)
2. All power and I/O connectors shall be two-part pluggable terminals so that when a module is replaced no wires have to be removed from the terminals.
3. The same basic RTU shall be used for all communications options with no I/O configuration changes.

K. Antenna Options:

1. Cellular options shall include an antenna that is internal to the enclosure, an omnidirectional antenna external to the enclosure or a directional (higher gain) antenna external to the enclosure.
2. Satellite RTU's shall require an external 3-inch stub antenna with a bracket and either a 15, 30 or 50-foot external cable.
3. IP units shall only require standard 10baseT RG6 Internet patch cable connection.

L. Expansion and Accessories. The RTU's shall have the following optional factory-installed accessories available: (Excluding HTT300)

1. Din-rail mounted main power surge arrestor.
2. Din-rail mounted Analog or Digital signal surge arrestors.
3. RTU's with four Analog inputs shall have an optional expansion module to add four additional 4-20ma analog inputs.
4. Enclosure heaters and thermostats
5. Local digital displays for analog inputs.
6. RTU's with a programming port through which qualified installers may upgrade internal software without returning the equipment to the factory.

M. Communication Platforms:

1. RTU's may be configured with either low earth orbit satellite (Iridium), GSM cellular, CDMA cellular, or IP (Internet) as designated by the Owner to communicate bi-directionally from the RTU to the server. Cellular or IP service is not guaranteed at the RTU sites. System supplier is required to verify that their proposed communication platform will function properly at each site prior to bid submittal.

N. Customer Service

1. The Manufacturer shall provide 24-hour, seven days a week phone support access to the Owner by the Manufacturer's customer support personnel. Customer support personnel shall provide assistance with software, communications and hardware as required by the Owner. The Manufacturer shall provide the Owner with a toll-free number to contact their customer support personnel. No additional fees shall be charged by the Manufacturer for configuring the Owner's software for his applications.

2.4 PERSONAL COMPUTER

A. A Windows based personal computer (PC) shall be supplied to run the SCADA operating program. The computer shall be supplied with the following hardware as a minimum:

1. 500 Watt Uninterruptible Power Supply (UPS) power backup system for PC and CTU
2. Desktop computer with keyboard and mouse
3. 3.6 GHz Intel Quad core i7 processor
4. 1 TB Hard Drive
5. 16 GB dual channel random access memory (RAM)
6. Two (2) – 24 inch high resolution color monitors
7. DVD/CD-RW optical disk drive
8. Four (4) – USB communication ports
9. Current Windows 10 Operating System Software
10. Current versions of Microsoft Office Software
11. Laser Color Printer, HP Color LaserJet Pro, or equal

B. Above items shall be shipped loose and system integrator shall provide installation. The installation site for the PC and all other necessary appurtenances shall be a clean and dry environment, suitable for the location of electronic equipment.

C. Computer is to be provided with a two (2) year, on-site, next business day warranty.

D. Computer is to be connected to internet service for purposes of programming and alarming. Internet connection is to be provided by Owner.

3.0 EXECUTION

3.1 INSTALLATION

A. Install all equipment in accordance with ANSI C2, ANSI/NFPA 70 and the requirements specified herein. Any existing SCADA equipment at the distribution sites shall be demolished.

B. Install all field instruments in accordance with the Manufacturer's recommendations. Any instrumentation or hardware necessary to obtain site information (i.e., pressure transducers, etc.) shall also be furnished with the distribution SCADA system.

3.2 WIRING

A. Install all conductors and cables in conduit, unless indicated otherwise.

B. Complete raceway systems and remove obstructions before pulling conductors into place. Avoid damaging insulation during conductor installation. Use an approved lubricating compound as required to facilitate pulling wires.

3.3 SPLICES AND TERMINATIONS

A. Make up both mechanically and electrically tight.

B. Provide with a flashover or insulation value at least 100 percent in excess of wire insulation.

C. Make all splices and terminations in UL approved junction boxes.

D. Make connections in No. 10 AWG and smaller conductors with insulated pressure connectors or wire nut connections.

E. Use terminal blocks of the proper voltage for interconnecting or splicing control cables, communication cables, and other conductors. Mount terminal blocks in a cabinet and label terminals properly.

3.4 ANTENNA MOUNTING

A. All antennas shall be mounted with galvanized clamps or other non-corroding attachment devices.

B. The mounting of the antennas shall be in such a manner to prevent welding, drilling or other corrosion and stress inducing modifications, or damage to paint systems.

C. All antennas shall utilize existing non-load bearing structures such as safety rails for mounting points.

D. Antennas shall be mounted in a manner so that cables and antennas do not interfere with safety equipment or harnesses while climbing up or on the structures.

E. Cutting into a structural member for the purpose of antenna mounting will not be acceptable.

F. All antennas shall be mounted to insure the most direct view of the sky at the remote sites.

G. Antenna masts shall be provided where necessary to elevate the antenna high enough to insure direct view of the sky, and shall include the mast and all attachment hardware necessary to provide a fully functioning antenna.

3.5 ANTENNA CONNECTION SEALING

A. All antenna connections shall be coated with an approved silicon based lubricant to prevent corrosion of connections, and then covered and sealed with a protective rubber boot.

3.6 TESTING AND START-UP

A. Performance Verification Test: System integrator shall conduct performance verification tests to satisfactorily demonstrate that the control system maintains

previously identified set-points, and that the system is programmed for the correct sequence of operations for all monitored aspects. Continuous RTU system performance verification testing shall be conducted the day after the system is installed. The performance verification testing shall demonstrate the following:

1. Field Testing: Calibrate field equipment and verify equipment and system operation before placing the system on-line.
2. Calibration Accuracy and Operation of Inputs Test: Check for proper calibration and operation of each input instrument. Document each reading for the test report.
3. RTU Startup and Memory Test: Demonstrate that programming is not lost after a power failure, and all RTU controllers automatically resume proper control after a power failure.
4. Surge Protection: Show that surge protection, meeting the requirements of this specification, has been installed on incoming power to the digital controllers and on communications lines.

3.7 FIELD TESTING

A. Demonstrate compliance of the control system with the contract documents. Furnish personnel, equipment, instrumentation, and supplies necessary to perform calibration and site testing. Ensure that tests are performed by competent employees regularly employed in the testing and calibration of instrumentation systems.

B. Notify the Owner of any defective products and workmanship disclosed by the tests.

C. Testing shall include the field and the performance verification tests. Field tests shall demonstrate proper calibration of input devices, and the operation of specific equipment. Performance verification test shall ensure proper execution of the sequence of operation and proper tuning of control loops.

D. Test each device such that each item will function not less than five times.

E. All testing is subject to oversight and approval by the Owner.

4.0 PAYMENT

A. The lump sum price entered in the bid form shall constitute full payment for supplying a complete and fully functioning SCADA system in accordance with these specifications including any and all fees required to operate and keep the system current, excluding internet access fees at the Water Treatment Plant, for a period of five (5) years.

END OF SECTION

SECTION 12350

LABORATORY CASEWORK

PART 1 - GENERAL

1.1 SCOPE

The casework contractor shall furnish all material, equipment, tools, labor and necessary insurance required to perform a complete installation in accordance with the specifications and applicable contract drawings.

1.2 WORK INCLUDED

Furnish all laboratory casework and equipment; deliver to the job-site, assemble, level, scribe and secure to floors or walls as required.

Furnish and deliver to the mechanical and electrical contractors all sinks, troughs, outlets, overflows traps, fixtures, switches and receptacles as specified and called for on the drawings as related to the laboratory casework.

Furnish, deliver and install all work, conduit, wiring, mechanical service piping, shut off valves, drain lines, vents, revents, special piping to meet local codes, vacuum breakers, ductwork and fume hood blowers a required or a shown on the contract drawings.

Receive, store, distribute, install and connect all electrical service fixtures, plumbing service fixtures, drain fittings traps, cup sinks and sinks supplied by the casework manufacturer. Contractor shall also furnish and install all framing, bucks, plaster grounds and reinforcement of walls, floors, and ceilings as necessary in order to support the casework.

1.3 MANUFACTURERS

All laboratory casework covered by this specification shall be the product of one manufacturer. Manufacturers furnishing equipment shall have been engaged in work of this type, for at least five years and shall have completed a minimum of 25 installations of equivalent size.

Casework shall be as manufactured by:

1. LOC Scientific
2. Mott Manufacturing
3. UniLine / HEMCO
4. Or approved equal

1.4 SAMPLES

All bidders, upon request shall be required to submit a sample cabinet made in accordance with this specification. Samples shall be delivered, at NO cost to the Engineer or Owner, to a destination set forth by the Engineer, seven days prior to bid date as a condition of approval of each bidder.

Samples shall be full size, production type samples with the approximate dimensions of 24” wide by 30” high x 22” deep, with one drawer and one door.

Samples may be held by the Owner or Engineer to insure that all equipment delivered conforms in every respect to the sample.

1.5 DRAWINGS

The casework contractor shall furnish project specific shop drawings for approval, describing and/or illustrating all equipment covered by this contract. Fabrication must not be started until prints with the Engineers “Final Approval” stamp affixed thereon, have been returned to the manufacturer.

1.6 GUARANTEE:

The casework contractor shall guarantee all materials and workmanship of equipment provided under this contract for a period of one year.

PART 2 - PRODUCTS

All materials shall be of the highest quality, whether they are finished parts used in Assembly, raw material, or materials and workmanship furnished by others, as part of the completed product.

All steel used in the manufacture of metal casework shall be cold rolled, prime grade, or better. Steel shall be inspected prior to fabrication and certified to be free of rust, pits, scratches, or any other defect(s) which prevent parts from being made to blueprint specifications.

Gauge specifications for individual steel parts shall be as follows:

Aprons	18 GA.
Back Panels	20 GA.
Bottom Panels	18 GA.
Door & Drawer Outer Pan	20 GA.
Door & Drawer Inner Pan	20 GA.
Drawer Bodies	20 GA.
Shelves	18 GA.
Side Panels	18 GA.
Tables Frames	18 GA.
Shelf Support Brackets	14 GA.

2.1 CONSTRUCTION

Cabinets: Cabinets shall be constructed of prime 18 gauge steel for the sides, backs, and toe space.

1" X 18 gauge steel tubing shall be used for the top front and back rails. Each front joint is to be welded and ground flush to provide a smooth surface. A 4" high X 3" deep toe space shall be standard. Four corners are to be fitted with a stamped and welded 14 gauge leveling gusset plate, and a plated leveling screw. Leveling screws are provided with a slot for easy adjustment, and non-marking nylon glides. Removable back panels shall be furnished on all cabinets. Cabinet bottom shall be panned up to contain spills and shall be removable for easy cleaning and maintenance.

Doors – Base Cabinet Doors: Doors shall be double pan construction, with insulating material fastened to the inside for sound deadening, and strength, to prevent panning and bending. Hinges shall be five knuckle heavy gauge stainless steel, fastened to both the door and cabinet frame with zinc plated steel screws. Door catches shall be plated, friction roller type. Door(s) shall close(s) onto nylon bumpers for noise dampening, and over nylon spacers for alignment.

Drawers: Drawer bodies shall be single piece 20 gauge construction, fully coved on all four sides horizontally and formed out of one sheet of steal.

Drawer Suspension: Drawers shall operate on full extension, ball bearing, zinc plated, drawer suspension rated to withstand 10,000 cycles at 100 lbs.

Shelves: Shelves shall be constructed of 18 gauge steel, with channels formed on both the front and back edges. K & V shelf clips are made from 14 gauge steel, and are to be adjustable vertically in 1" increments.
Sliding shelves shall use the same ball bearing slides as drawer units.

Fabricated Accessories: All accessories required for specific installations shall be fabricated and finished to the same material and quality standards as the base units they will be made to compliment.

Wall Cabinets: Wall Cabinets shall be made to the same quality standards as base units. Material shall be used, as noted above. Shelve hangers are to be constructed of 14 gauge steel, and to easily adjust vertically in one inch increments.

Shelves are to be constructed with channel type fronts and backs, as well as flanged ends with nylon button glides. Wall units are to have open fronts, slid glass, framed glass sliding and swinging, or sliding and swinging steel doors as specified or as shown on the contract drawings. Door glass shall be plate type, ground on all exposed edges.

Sliding door units are to be furnished with extruded top and bottom channels as well as ball bearing rollers. All wall units are to be furnished with hanger brackets for ease of

installation.

Floor Units: Floor Units shall be made to the same quality standards as base units. Material shall be used, as noted above. Shelves and shelf hanger construction, same as wall units.

Floor units to be furnished with the same front and door configurations as the above described wall units.

2.2 FINISH

This section of the specification establishes the performance and appearance requirements for the interior decorative coatings and used on laboratory products. The material to be used for the coasting will be applied dry over metallic substrates. The material shall be available in a number of colors. All surfaces shall be painted or plated, whether they are exposed or not. Paint is to be a chemically resistant baked on epoxy powder coat enamel. Finish color to be selected by owner.

The finish coating material shall be such that it can be applied in multiple coatings where needed, without inter-coat sanding. The shelf life of the material shall be six (6) months at not more the 77°F without deterioration of properties. Coating material shall adhere to the following listed properties:

Appearance	**Test Procedure**	**Requirement**
A. Color	AES-C-0100	Pass
B. Light Resistant	QUV A Apparatus	48 hours w/o change in color or gloss
C. Thickness	Mill Gage	See page 3 of 3
D. Glass	ASTM D523-80 60 Degrees Glossmeter	30 Degree + 5 Matte 20 Degree + 5 Black
Performance		
A. Hardness	ASTM D3363-74	3-H Min.
B. Impact Resistance	ASTM D2794-69	120 in-lbs w/o cracking
C. Flexibility	ASTM D522-60	No cracking or loss of adhesion at bend
D. Abrasion	Tabor abrasor CS 10 Wheel	14 mg. max weight loss per 100 cycle
E. Humidity	ASTM D2247	288 hours exposure with no loss of adhesion or blistering

F. Salt Spray	ASTM B117-64 ASTM D1654-79	144 hours exposure with no rust. Max 1/8” rust creep from scribble line.
G. Adhesion		90 of the squares show finish

2.3 CHEMICAL RESISTANCE

A door shall be removed from the cabinets and laid flat and level on a horizontal surface. Chemical spot tests shall be made by applying 10 drops (approximately 0.5 cm^3) of each reagent listed in the table below to the surface to be tested. Each reagent spot shall be open to the atmosphere. Ambient temperature shall be 68°-72°F. After one hour, chemical shall be flushed away with cold water and the surface washed with detergent and warm water at 150°F. Surface shall then be examined for any changes in conditions. A maximum of three failure classifications shall be considered acceptable.

Reagent	Concentrations by Weight	Reagents	Concentrations by Weight
Acetic Acid	98%	Acetone	
Formic Acid	88%		
Hydrochloric Acid	37%	Ethyl Acetate	
Nitric Acid	25%	Ethyl Alcohol	
Nitric Acid	60%	Ethyl Ether	
Phosphoric Acid	75%	Formaldehyde	37%
Sulfuric Acid	25%	Hydrogen Peroxide	5%
Sulfuric Acid	85%	Methyl Ethyl Ketone	
Ammonium Hydroxide	28%	Phenol	85%
Sodium Hydroxide	10%	Xylene	
Sodium Hydroxide	25%		

2.4 EPOXY RESIN COUNTERTOP

Tops and curbs shall be molded from a modified epoxy resin that has been especially compounded and cured to provide optimum physical and chemical resistance required for a heavy duty laboratory working surface.

Impregnated stone and/or furane resins will not be considered equal. Tops and curbs shall be a uniform mixture throughout, and shall not depend on a surface coating that can be readily removed by chemical or physical abuse.

Tops and curbs shall be non-glaring matte finish and black in color.

Tops shall be a thickness as required with a drip groove provided on underside of all sink top exposed edges. All edges shall have a slight radius.

Curbs shall be bonded to the surface on the top to form a square water-tight joint. All

joints in tops to be bonded with an approved epoxy cement and shall be smooth and water-tight.

Counters with integral curbs shall have a junction with a ¾" radius, except around columns and special cutouts, which will have a standard bonded curb.

All tops and curbs shall adhere to the following physical properties:

Flexural Strength	ASTM-Method D-790	16,000 psi
Compressive Strength	ASTM-Method D-695	36,500 psi
Hardness Rockwell M	ASTM-Method D-785	110
Density Gr./CC.	ASTM-Method D-792	123.55 lbs./ft³
Water Absorption	ASTM-Method D-570	0.0076%
Flame Test	ASTM-Method D-635	Self-extinguishing

PART 3 - EXECUTION

3.1 EXAMINATION

Examine casework substrates, and all necessary structural support, anchorage, and conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work. Verify all dimensions, and operational clearances. Examine other built-in components to ensure a coordinated, well executed installation.

Masonry Surfaces: Shall be visibly dry and free of excess mortar, sand, and other construction debris.

Wood Frame Walls: Dry, clean, sound, well nailed, free of voids, and without offsets at joints. Ensure that nail heads are driven flush with surfaces in order to prevent any interference with the installation of casework and accessories.

Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.

Proceed with installation only after unsatisfactory conditions have been corrected. Casework shall not be installed until all surface preparation has been completed, including final painting, if necessary.

3.2 INSTALLATION

Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing casework, hardware, accessories, and other components.

Install casework level, plumb, square and true to line, without distortion or movement, anchored securely in place to structural support.

Install sinks, faucets, and other related components to building plumbing and drains in accordance with all applicable building codes. Any electrical accessories to be included with casework shall be installed in accordance with all applicable electrical codes and in accordance with Division 16 specifications.

3.3 ADJUSTING, CLEANING, AND PROTECTION

Adjust all doors and drawers, hardware, and accessories for a tight fit at contact points and to ensure smooth operation and tight closure. Lubricate all hardware and moving parts upon completion of installation.

Contractor shall clean all glass, if applicable, and casework upon completion of installation.

Protection of newly installed casework and/or final cleaning of glass to remove any accumulations that may have occurred during the construction period is to be the responsibility of the General Contractor.

Installer shall comply with all of the manufacturer's written recommendations for storing, installing, adjusting, final cleaning and maintenance.

END OF SECTION

SECTION 13100

IN PLANT AND VAULT PIPING

1.0 GENERAL

1.1 SCOPE OF WORK

Provide all labor, materials, equipment and services required to furnish and install all plant process piping as shown on the Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Yard Piping and Valves: Section 13101

B. Waterlines: Section 13103

C. Housed Valves: Section 13500

2.0 PRODUCTS

2.1 DUCTILE IRON PIPE/DUCTILE AND CAST IRON FITTINGS

Unless otherwise noted or required, all inside ductile iron piping shall be flanged pipe with threaded flanges in accordance with ANSI A21.51 (AWWA C151) and ANSI A21.15 (AWWA C115). All piping shall be rated for 250 psi unless otherwise noted and shall have ring gaskets, 1/8-inch thick.

All exposed iron pipe to be field painted shall be furnished with an external coating of rust inhibitive primer per the specifications. Do not apply asphalt or bituminous coatings on pipe to be painted.

The interior of ductile iron pipe shall be cement-mortar lined with bituminous seal coat in accordance with AWWA C 104.80. Thickness of the lining shall be as set forth in Section 4-10.1 of the aforementioned specification unless otherwise directed by the Engineer.

Ductile and cast iron fittings shall conform to ANSI A21.10 AWWA C110 with flanges faced and drilled 125-pound. Fittings 12-inch and smaller shall be 250 psi ductile iron. Fittings shall have interior lining and exterior coating same as the pipe.

2.2 PLASTIC PIPE AND FITTINGS

All exposed interior PVC process piping shall be ASTM D 1785, Schedule 80, Type 1, Grade 1. Joints shall be solvent welded. Use flanged connections where required for

connection to appurtenances or where indicated on the Drawings. All plastic pipe, fittings and valves shall be suitable for minimum 200 psi operating pressure.

2.3 WALL PIPE AND SLEEVES

All wall pipe shall be furnished with cast or welded collar waterstops. Welding of water stop collars on pipe shall be accomplished by the wall pipe manufacturer in their shop. Centrifugally cast wall pipe shall be ductile iron meeting the requirements of AWWA C151 for the pipe barrel, conforming to the pressure rating of the pipeline in which installed. All statically cast wall pipe shall be gray or ductile iron meeting the requirements of AWWA C110 for fittings. Mechanical joint end and cast-on flange end wall pipe shall conform to AWWA C110 and threaded flange wall pipe shall conform to AWWA C115. Where flanged or mechanical joint bell ends are flush with the wall, they shall be drilled and tapped for stud bolts. Bolts shall be constructed from 300 Series stainless steel. The length of all wall pipe shall be not less than the thickness of the wall in which installed. Wall pipe shall be cement-mortar lined per AWWA C104. The exposed end of wall pipe inside structures shall be shop primed for field painting; embedded portion left uncoated; exterior buried portion coated with standard bituminous coating.

Contractor may have the option to install wall pipe flush face-to-face of wall in lieu of the dimensioned length wall pipe shown on the Drawings, in order to eliminate form penetrations. This option will be subject to Engineer's review at each wall pipe location and covers both flanged and mechanical-joint bell-end wall pipe. Embedded flanged and M.J. bell-end bolt holes shall be tapped for stud bolts; tapped bolt holes in embedded flanges shall be plugged for protection during concrete pouring.

All pipe wall sleeves shall be plain end galvanized steel pipe. Sleeve length to fit flush face-to-face of wall. Link-Seal, or equal, shall be used to seal void between the carrier pipe and sleeve. Non-shrink grout shall be used on both ends to fill remainder of void flush with wall.

2.4 INTERLOCKING LINK PIPE SEALS

Link pipe seals shall be used in lieu of packing a pipe wall sleeve. Seals shall be modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and wall sleeve.

The Contractor shall determine the required diameter of each individual wall opening according to the manufacturer's recommendations before ordering and installing the seal. Pipe shall be accurately centered in the sleeve and the link seals shall be sized,

installed and tightened in accordance with the manufacturer's instructions. Remainder of void to be filled with non-shrink grout.

2.5 FLANGE COUPLING ADAPTER (FCA)

Flange Coupling Adapters (FCA) shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C115/A21.15. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges. “Quick Flange” or “EZ Flange” configurations using only set screws for restraint will not be accepted. The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6” gap between the end of the pipe and the mating flange without affecting the integrity of the seal. For PVC pipe, the flange adapter will have a pressure rating equal to the pipe. For Ductile Iron Pipe, the flange adapter shall have a safety factor of 2:1 minimum.

2.6 FLANGED JOINTS

Flange bolts and nuts shall be ASTM A 307, Grade B and shall have hexagonal heads. All bolts, nuts and studs for flanged pipe in submerged locations shall be of 300 Series stainless steel. The flanges shall be drawn together until the joint is perfectly tight, with bolts of a length such that they will not project greater than 1/4-inch from the nut nor fall short of the end of the nut when drawn up. No washer shall be used. Gaskets shall be carefully fabricated prior to installation and must be suitable for pressure rating for the pipe for which it is used.

All flanges (unless otherwise indicated or required) shall be faced and drilled ANSI A21.15 125-pound for ductile iron and rated for 250 psi.

2.7 PIPE SUPPORTS AND HANGERS

The Contractor shall furnish and install all pipe hangers, inserts, brackets, plates, anchors, and other supports not specifically included under other items. Generally, pipe supports are not shown on the Drawings, but shall be supplied as specified herein. However, any bracing or support details shown on the Drawings shall be followed.

Supports and hangers shall be as manufactured by Anvil, Elcen, B-Line, or fabricated by the Contractor. Field fabricated supports may be used only for special conditions where manufactured items may not be suitable. In such cases, details of proposed supports shall be submitted to the Engineer for review. All such supports shall be galvanized.

Except as shown on the Drawings or as directed by the Engineer, supports and hangers shall be as follows:

A. Pipes with centerlines less than 24 inches from a wall shall be supported by a typical wall support bracket. Pipes with centerlines less than 6 feet above a floor shall be supported from below. All other pipes shall be hung from above. Piping shall be supported at no greater than 10'-0" on centers.

B. Pipe supported from underneath shall have adjustable pipe saddle supports on properly sized pipe stanchions. The saddle assembly shall be of cast iron.

C. Hangers are to be suspended from concrete work. Hangers shall be supported from approved metal inserts placed in concrete before the concrete is placed.

D. All pipe hangers, inserts, clamps, supports and other like items shall be submitted for review by the Engineer prior to installation.

E. All inside horizontal flanged piping shall be supported with approved split ring type adjustable hangers of malleable iron with suitable hanger rods unless shown otherwise on the Drawings. Special supports shall be constructed in accordance with details shown on the Drawings. Wall supports and/or hangers shall be placed not over 10'-0" apart. All piping shall be rigidly supported to prevent loosening under vibration.

F. Pipe, valve operating stems, fixtures and conduits shall be bracketed or suspended from walls, ceilings, and beams at or near valves and fittings and where needed for firm support, by standard brackets, rods, turnbuckles, and rings made especially for pipe of sizes supported. Perforated strap iron and/or copper will not be acceptable.

G. Clevis hangers for "iron pipe size" O.D. pipe shall be Anvil Figure 260, Elcen Figure 12, or equal.

H. Turnbuckles shall be forged steel. Rods shall be of black steel, machine threaded of following sizes:

Pipe Size	Rod Diameter
1/2" - 2"	3/8"
2 1/2" - 3"	1/2"
4" - 5"	5/8"
6"	3/4"
8" - 12"	7/8"
14" - 16"	1"
18"	1 - 1/8"
20" - 24"	1 - 1/4"

I. Brackets shall be of standard castings of fabricated steel and shall be reviewed by the Engineer.

J. Column type pipe supports shall consist of pipe columns of size required to carry the full pipe and standard cast iron bases and saddles as required. Saddles shall be of proper size to fit the pipe being supported.

3.0 EXECUTION

3.1 INSTALLATION

A. All materials shall be new.

B. Each piece of iron pipe and each fitting shall be plainly marked at the foundry with class number and weight.

C. Where indicated on the Drawings, plain-end pipe shall be joined by means of flanged coupling adapters.

D. All pipe couplings shall be designed to safely withstand the operating pressure of the lines in which they are installed. All couplings shall be shop primed with an approved rust inhibitive primer.

E. Taps and connections to piping shall be made as required to connect equipment, sample lines, etc., and where otherwise shown on the Drawings.

F. Piping shall be installed straight and true, parallel or perpendicular to walls, with approved offsets around obstructions. Standard pipe fittings shall be used for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted unless accepted by the Engineer.

G. All piping, fittings, valves and other accessories shall be thoroughly cleaned of dirt, chips and foreign matter before joint connections are made.

H. All plastic pipe shall be adequately supported and braced. Support spacing shall not exceed the recommendations of the Plastics Pipe Institute.

I. Teflon tape shall be used on all plastic pipe threaded connections.

J. Field cut male threads on plastic pipe shall be made with plastic pipe threading dies.

K. The annular space of plain wall sleeves shall be packed tight with lead wool to within 3/4" of wall face and then patch grouted flush to wall face with non-staining non-shrink grout, Masterflow 713 by Master Builders, Sonogrout by Sonneborn-Contech, or equal.

L. All pipe sleeves passing through walls or floors of chlorine feed and storage areas shall be provided with gas tight seals.

M. All pipe threads shall conform to ANSI B2.1.

N. Piping shall be erected to provide for expansion and contraction.

O. Screwed or soldered unions shall be provided in all small piping as required to permit convenient removal of equipment, valves and piping accessories from the piping system.

P. Dielectric insulating couplings or brass adapters shall be used whenever the adjoining materials being connected are of dissimilar material such as connections between copper tubing and steel pipe.

Q. All inside piping shall be color coded, stenciled and label tagged for identification.

R. All flanged pipe shall be installed with at least one factory assembled flanged end. Flange coupling adaptor may be used for the opposite end.

4.0 MEASUREMENT AND PAYMENT

No separate measurements or payment shall be made for in plant and vault piping. Payment for this item shall be included in the work which it is subsidiary in the Bid Schedule.

END OF SECTION

SECTION 13101

YARD PIPING AND VALVES

1.0 GENERAL

1.1 SCOPE OF WORK

The Contractor shall provide all labor, materials, equipment and services required for furnishing and installing all yard piping and valves required for a complete and operating installation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. In-Plant and Vault Piping: Section 13100

B. Waterlines: Section 13103

C. Valves: Section 13500

1.3 BURIED VALVES

Buried valves shall be furnished with either mechanical joint or slip joint connections as governed by AWWA C111/ANSI A21.11. Valves shall be furnished with a standard 2" square operating nut, valve box and cover. Valve stem extensions shall be provided for all valves buried deeper than 3 feet. Valves shall be designed for low torque operation; 60 pound pull force on standard valve wrench. Valves requiring excessive torque for opening and closing shall be equipped with geared reducers. Concrete support blocking shall be installed under all valves larger than 4 inch. The valves interior and exterior shall be coated with the manufacturer's standard protective coating.

2.0 PRODUCTS

2.1 DUCTILE IRON PIPE

Ductile iron pipe shall conform to AWWA C151-76 Class 50, with push-on or mechanical joints.

The interior of the pipe shall be cement-mortar lined with bituminous seal coat in accordance with AWWA C104. Thickness of the lining shall be set forth in Section 4.10.1 of the aforementioned specification unless otherwise directed by the Engineer. The exterior of all pipe, unless otherwise specified, shall receive either coal tar or asphalt base coating a minimum of 1 mil thick.

Each piece of pipe shall bear the manufacturer's name or trademark, the year in which it was produced and the letters "DI" or the word "DUCTILE". Pipe manufacturer shall furnish notarized certificate of compliance to the above AWWA or ANSI specifications.

Fittings shall be Class 250 ductile iron in accordance with AWWA C110 or C153 latest revision and shall conform to the details and dimensions shown therein. Fittings shall have mechanical joints meeting the requirements of AWWA C111 latest revision. Fittings shall have interior cement-mortar lining as specified for the pipe.

Joints shall be of the mechanical joint type conforming to AWWA C111 latest revision. Mechanical joints shall be bolted and of the stuffing box type and shall consist of a bell, with exterior flange and interior recess for sealing gasket, a pipe or fitting plain end, a sealing gasket, a follower gland, tee-head bolts and hexagon nuts. Below floor slabs and on all high-pressure lines, the mechanical joints shall also be fitted with retainer glands.

The cleaning and assembly of pipe and fitting joints shall be in accordance with the manufacturer's recommendations.

2.2 POLYVINYL CHLORIDE (PVC) SEWER PIPE

Polyvinyl chloride plastic gravity sewer pipe shall be ASTM D 3034, SDR 35, with ASTM D 32123 integral bell and spigot rubber gasketed joints.

2.3 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

Polyvinyl chloride plastic pressure pipe shall be Class 200 (DR14) pipe conforming to the requirement of AWWA C900 for sizes 4 through 12 inches. Pipe sizes larger than 12 inch shall conform to AWWA C905 and pressure rated for 235 psi (DR18).

Cast or ductile iron mechanical joint or push-on type fittings shall be used with PVC pipe. No PVC fittings will be allowed.

Pipe and fittings shall be visually inspected on the project site for proper markings which shall include manufacturer's name or trademark, nominal pipe size, class pressure rating for water at 73.4°F, plastic pipe material designation (e.g. PVC 1120), ASTM Designation D2241 and the NSF Logo.

2.4 POST HYDRANTS

Post Hydrants shall be 2-1/8" post type manufactured to the quality and workmanship outlined under AWWA C502. The post hydrant shall be designed for 150-psi working pressure with a 3” mechanical joint bottom connection and 1-1/2" hose nozzle with cap and cap chain.

All hydrants shall be installed with isolating gate valves. Valve shall be sized the same as the bottom connection and as specified in this Section.

2.5 FIRE HYDRANTS

Fire Hydrants shall conform in all respects to the requirements of AWWA C502. Hydrant barrel shall have safety breakage feature above the ground line. All hydrants shall have 4-inch mechanical joint shoe connection, two (2) 2-1/2-inch discharge nozzles and one (1) 4-1/3-inch pumper nozzle with caps fitted with cap chains. Connection threads shall conform to local standards. Main valve shall have 5-1/4-inch full opening and be of the compression type opening against water pressure so that valve remains closed should barrel be broken off.

Hydrants shall be fully bronze mounted. Main valve shall have a threaded bronze seat ring assembly of such design that it is easily removable by unscrewing from a threaded bronze drain ring. Bronze drain ring shall have multiple ports providing positive automatic drainage as the main valve is opened or closed. Drainage waterways shall be completely bronze to prevent rust and corrosion.

Operating stem shall be equipped with anti-friction thrust bearing to reduce operating torque and assure easy opening. Stop shall be provided to limit stem travel. Stem threads shall be enclosed in a permanently sealed lubricant reservoir protected from weather and the waterway with O-ring seals.

Hydrants shall be designed for 150 psi working pressure and shop tested to 300 psi pressure with main valve both opened and closed. Under test the valve shall not leak, the automatic drain shall function and there shall be no leakage into the bonnet.

All hydrants shall be installed with isolating gate valves. Valve shall be sized the same as the bottom connection and as specified in this Section.

2.6 BUTTERFLY VALVES

Butterfly valves shall conform to the specifications of Section 13500 except be designed for buried service, have mechanical joint ends, have all exterior surfaces shop painted with two coats of Fed. Spec. TT-V-51F asphalt varnish, and furnished with 2-inch square AWWA Class 150B nut operator in a vertical position for use in a valve box.

2.7 GATE VALVES

Gate Valves shall conform to the specifications of Section 13500 except be designed for buried service, have mechanical joint ends, have all exterior surfaces shop painted with two coats of Fed. Spec. TT-V-51F asphalt varnish, and furnished with 2-inch square nut operator in a vertical position for use in a valve box.

2.8 PLUG VALVES

Plug valves shall conform to the specifications of Section 13500 except be designed for buried service; have mechanical joint ends; have all exterior surfaces shop painted with two coats of Fed. Spec. TTV-51F Asphalt varnish, with 2-inch square nut operator in a vertical position for use in a valve box.

2.9 VALVE BOXES

Valve boxes shall be of 5-1/4 inch standard cast iron, two-piece, screw type valve box with drop cover marked "WATER", "SEWER", "DRAIN", as applicable. Valve boxes shall be accurately centered over valve operating nut, and backfill thoroughly tamped about them. Valve box bases shall not rest on the valves but shall be supported on crushed stone fill. They shall be set vertically and properly cut and/or adjusted so that the tops of boxes will be at grade in any paving, walk or road surface, and 2 to 3 inches above ground in grass plots, fields, woods or other open terrain. In grass areas, provide concrete pad around valve box; slightly crown in all directions to shed water.

2.10 MANHOLES

Manholes of the dimensions indicated on the Drawings shall be built as directed. The manhole proper shall be constructed of ASTM C478 precast reinforced concrete manhole sections erected on 3,000-psi concrete foundations. Pipe shall be grouted into manhole openings.

A. Standard Manholes: The standard manhole shall be six feet or less in depth, measured from the base of the cover frame to the invert of the outlet and shall be eccentric cone type.

B. Shallow Manholes: The shallow manholes shall be five feet or less in depth, measured from the base of the cover frame to the invert of the outlet and shall be of flat top construction.

C. Precast Concrete Eccentric Cones: Precast concrete eccentric cones shall be of the size indicated on the Drawings and shall conform to ASTM C 478.

D. Precast Manhole Section Joints: Precast manhole section joints shall be mortared or grouted; joined with ASTM C443 rubber gaskets; or joined with AASHTO M-198-75 preformed flexible butyl type joint sealant, Hamilton-Kent "Kent-Seal No. 2", K.T. Snyder Co. "Rub'r-Neck", Press Seal Gasket "E-Z Stik" or "CPS-210", Concrete Sealants, Inc. "Conseal", or equal. Manhole section joints shall be watertight.

E. Manhole Inverts: Manhole inverts shall be formed with 3,000 psi concrete as shown on the Drawings. Inverts for "straight-through" manhole may be formed by laying the pipe straight through the manhole, pouring the concrete invert, and then

breaking out the top half of the pipe. Curved invert shall be constructed of concrete as shown. The inverts shall form a smooth, even half-pipe section as shown. The inverts shall be constructed when the manhole is being built using prefabricated forms.

The excavation shall be kept free of water while the manhole is being constructed and the manhole shall not be backfilled until inspected by the Engineer.

F. Manhole Steps: Manhole steps shall be constructed from polypropylene plastic. Steps shall be driven into specifically sized holes cast into the manhole barrel. Holes shall be formed in the manhole barrel using an insert plug, which is removed upon curing. Step spacing of 12" to 15" is acceptable.

G. Manhole Frames and Covers: Manhole frames and covers shall be Neenah Foundry Company R-1763 with vented lids lettered "DRAIN", Vulcan Foundry, or equal. Catch basin frames and grates shall be Neenah Foundry Company R-2533, Vulcan Foundry, or equal. Manhole covers must set neatly in the rings, with contact edges machined for bearing and tops flush with ring edge. The same frames will be acceptable for both manhole covers and catch basin grates.

3.0 EXECUTION

3.1 YARD PIPING INSTALLATION

A. Yard piping trenching, bedding, laying and backfilling shall be in accordance with Section 13103 of these Specifications unless otherwise noted on the Drawings.

B. Excavation for Pipeline Trenches: Trenches in which pipes are to be laid shall be excavated in accordance with Section 13103 Specifications to the depths shown on the Drawings or as specified by the Engineer. Minimum cover for all pipelines shall be 30-inches.

C. Jointing: The types of joints described hereinbefore shall be made in accordance with the manufacturer's recommendations.

D. Concrete Anchors and Encasements: Contractor shall install concrete anchors and encasement as shown on detail sheets and where indicated on the Drawings for pressure mains.

E. Backfilling Pipeline Trenches: Backfilling of pipeline trenches shall be accomplished in accordance with the requirements set forth in Section 13103, Article 8 of these Specifications and as shown on the Drawings.

Before final acceptance, the Contractor will be required to level off all trenches or to bring the trench up to the level of the surrounding terrain. The Contractor shall also

remove from roadways, rights-of-way and/or private property all excess earth or other materials resulting from construction.

In the event that pavement is not placed immediately following trench backfilling in paved areas, the Contractor shall be responsible for maintaining the trench surface in a level condition at proper pavement grade at all times.

F. Testing: Testing of yard piping shall be accomplished in accordance with Section 13103, Article 13 of these Specifications, except as modified hereinafter.

1. Loss of water pressure during test of pressure piping (lines not laid to grade) shall not exceed 10 psi in a 24-hour period or 5 psi in an 8-hour period.

2. Contractor shall furnish a recording gauge and water meter for measuring water used during leakage test and recording pressure charts during duration of test. Recording pressure charts shall be turned over to the Engineer at conclusion of tests.

3. Piping laid to grade shall be visually inspected by the Engineer from the outside before backfilling and from manhole to manhole (or headwall) for trueness of line and grade and integrity of joints.

G. Disinfection of Potable Water Lines: The new potable waterlines shall not be placed in service--either temporarily or permanently--until they have been thoroughly disinfected in accordance with the following requirements and to the satisfaction of the Engineer.

After testing, a solution of hypochlorite using HTH or equal shall be introduced into the section of the line being disinfected sufficient to insure a chlorine dosage of at least 50 ppm in the main. While the solution is being applied, the water should be allowed to escape at the ends of the line until tests indicate that a dosage of at least 50 ppm has been obtained throughout the pipe. Open and close all valves and cocks while chlorinating agent is in the piping system. The chlorinated water shall be allowed to remain in the pipe for 24 hours, after which a residual of at least 25 ppm shall be obtained. The disinfection shall be repeated until 25 ppm is obtained after which time the main shall be thoroughly flushed until the residual chlorine content is not greater than 1.0 ppm, and then may be connected to the system.

H. Clean-up: Upon completion of the installation of the piping and appurtenances, the Contractor shall remove all debris and surplus construction materials resulting from the work. The Contractor shall grade the ground along each side of pipe trenches in a uniform and neat manner leaving the construction area in a shape as near as possible to the original ground line.

END OF SECTION

SECTION 13102

WATERLINES

1.0 GENERAL

The CONTRACTOR shall furnish all labor, materials and equipment to install the water lines as shown on the plans and as specified herein.

The water lines may either be pressure-rated municipal plastic pipe (MPVC) or ductile iron (DI), all as specified hereinafter.

1.1 RELATED WORK SPECIFIED ELSEWHERE

A. In-Plant and Vault Piping: Section 13100

B. Yard Piping and Valves: Section 13101

C. Housed Valves: Section 13500

2.0 MATERIALS

2.1 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

This specification covers rigid, pressure-rated, polyvinyl chloride pipe and fittings, hereinafter called PVC pipe and PVC fittings, for sizes 1/2 inch through 24-inch. Pipe shall be as manufactured by JM Eagle, North American Pipe Company, or approved equal.

2.1.1 General.

2.1.1.1 Pipe Markings. Depending on the type of PVC pipe being used, the following shall be marked along the length of each joint of pipe: manufacturer's name, nominal pipe size and size base, material code (PVC 1120), dimension ratio or standard dimension ratio, pressure class or rating, production record code, certification seal (NSF logo), and specification designation (i.e., ASTM 2241, AWWA C900, etc.).

2.1.1.2 Underground Marking for PVC Pipe. Underground marking for pipe shall use both tracing wire and marking tape.

2.1.1.2.1 *Underground Tracer Wire.* A detectable underground tracer wire shall be placed in the trench directly on top of the pipe. Wire shall be taped to the top of the pipe. The wire used shall be 12 AWG solid HDPE 30 MIL copper conductor with a 30 mil thick, high-density, high molecular weight polyethylene (HDPE) insulation and rated for 30 volts. Extreme care shall be exercised in splicing wire ends to assure continuity.

Wire nuts designed specifically for buried service shall be used at all splices. At each valve box the wire shall be looped to the surface extending 12 inches above the concrete valve box pad (see Std. Dwg. for valve). When the entire project or pipeline segment is complete, including meter installation and leak repairs, the locating wire system shall be checked for continuity. Tracer wire to be provided by Pro-Line Safety Products, or approved equal. Wire insulation color shall be blue.

2.1.1.2.2 *Underground Marking Tape*. A detectable underground marking tape shall be placed in the trench approximately 12 inches below the finished grade. The tape used shall be laminated aluminum foil with the printing "CAUTION - Buried Water Line Below". Printing shall be readable through the clear poly lamination and surface printing is not acceptable. Tape size shall be 2 inch width as provided by Presco Products, or approved equal. Color of the tape shall be blue.

2.1.2 Polyvinyl Chloride (PVC) Pipe—ASTM Standard

2.1.2.1 PVC Pipe. PVC pipe shall be extruded from Type 1, Grade 1, polyvinyl chloride material with a hydrostatic design stress of 2,000 psi for water at 73.4°F, designated as PVC 1120, meeting ASTM Specifications D-1784 for material and D-2241 for pipe, latest revisions. Pipe shall also meet all applicable provisions of the Product Standards and shall bear the National Sanitation Foundation (NSF) seal of approval in compliance with NSF Standard No. 14. PVC pipe having a maximum hydrostatic working pressure of 160 psi (SDR-26), 200 psi (SDR-21), 250 psi (SDR-17), or 315 psi (SDR-13.5) shall be used as shown in the Bid Documents and Plans.

Samples of pipe and physical and chemical data sheets shall be submitted to the ENGINEER for review and determination of compliance with these specifications before pipe is delivered to job. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects.

The workmanship, pipe dimensions and tolerances, outside diameters, wall thickness, eccentricity, sustained pressures (ASTM D-1598), burst pressures (ASTM D-1599), flattening, extrusion quality (ASTM D-2152), marking and all other requirements of the Product Standard PS 22-70 shall be conformed with in all respects. No pipe, 2 inches in diameter or larger, with a wall thickness less than 0.090 inches may be used.

Pipe shall be furnished in 20 feet lengths. The pipe may be double plain end or with bell on one end. Male ends of pipe must be beveled on the outside. Pipe shall have a ring painted around the male end or ends in such a manner as to allow field checking of setting depth of pipe in the socket. This requirement is made to assist construction superintendents and inspectors in visual inspection of pipe installation.

Pipe must be delivered to job site by means which will adequately support it, and not subject it to undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical. Pipe must not be

exposed to the direct rays of the sun for an extended period of time. If pipe is not to be installed shortly after delivery to the job site, it must be stored in a shaded location and strung as needed.

2.1.2.2 PVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Pipes with bells shall have all parts of the bell, including the gasket groove, made from the same extruded piece, integral with the pipe, and shall be thickened to meet standard dimension ratios of wall thickness to outside diameter. This manufacturing procedure shall be the normal practice of the pipe manufacturer and proven by past performance of pipe in service. The gasket groove shall be constructed such that gasket rollout will not occur. Rubber gasketing shall conform to ASTM D-3139.

Joint lubricant shall be of a type recommended by the manufacturer for their pipe subject to the Engineer approval. Lubricant shall be water soluble, non-toxic and have no objectionable properties.

Due to special requirements for special gaskets for use within 200 feet of underground fuel tanks, gas lines, and/or oil transport lines, PVC pipe shall not be used under these circumstances.

2.1.2.3 PVC Couplings. Where PVC couplings are used, they shall be of the same material as the pipe and may be of the molded, or extruded type. PVC couplings shall have a minimum pressure rating equal to the pipe in which it is being used, but no less than 200 psi for continuous operation at 73.4 °F.

2.1.2.4 Fittings Ductile iron mechanical joint fittings shall be used with PVC pipe. All such fittings shall be approved by the pipe manufacturer, and complete data sent to the ENGINEER, including the manufacturer's approval, for review. Fittings shall comply with AWWA C-153 (C-110, if applicable) and shall be manufactured for the size and pressure class of the line on which they are used. Coatings and lining shall be in accordance with section 2.2.8 of the Specifications.

2.1.2.5 Service Connections. All service connections on PVC lines shall be made by means of a bronze service clamp, manufactured specifically for use with PVC pipe and appropriate corporation stop.

2.1.3 Polyvinyl Chloride (PVC) Pipe—AWWA C900 & C905 Standard.

This specification covers the requirements for AWWA approved Polyvinyl Chloride Pressure Pipe for water supply and distribution systems.

2.1.3.1 PVC Pipe—AWWA C900 & C905 Standard. PVC pipe shall meet the requirements of AWWA C900 and C905, latest revision and shall be furnished in cast-iron pipe equivalent outside diameters with rubber gasketed joints.

C900 and C905 PVC pipe shall be made from Class 12454-A or Class 12454-B virgin compounds as defined in ASTM D-1784. The standard code designation shall be PVC 1120. The PVC compounds shall be tested and certified as suitable for potable water products by the NSF Testing Laboratory and shall carry the NSF approval marking.

Solvent-cement couplings or joints shall not be used. PVC joints using elastomeric gaskets shall be tested as assembled joints and shall meet the laboratory performance requirements specified in ASTM D-3139.

Pipe shall be DR (Dimension Ratio) 14 or 18 as shown on the plans or the bid form.

Pipe and couplings shall meet or exceed the following test requirements:

Hydrostatic Integrity - Each standard and random length of pipe shall be proof-tested at four times its rated class pressure for a minimum of 5 seconds. Bells or couplings shall be tested with pipe. The pipe and couplings shall further meet or exceed the pressure test requirements of ASTM D-1598 and D-1599.

Flattening - The pipe shall not split, crack, or break when tested by the parallel-plate method as specified by ASTM D- 2241.

Extrusion quality - The pipe shall not flake or disintegrate when tested by the acetone-immersion method as specified in ASTM D-2241.

Standard length - Pipe shall be furnished in standard laying lengths of 20 ft. ± 1 in. A maximum of 15 percent of each pipe size may be furnished in random lengths of not less than 10 ft. each.

2.1.3.2 PVC Pipe Jointing. Pipe shall be joined with slip-type joints with rubber gaskets. Manufacturing and installation procedures shall be as recommended by the manufacturer and as described for PVC pipe in section 2.1.2.2 of this specification.

2.1.3.3 Fittings. Fittings for municipal PVC shall be ductile iron only. Fittings shall be mechanical joint. Fittings shall be manufactured for the size and pressure class of the line on which they are used and shall comply with AWWA C-153 (C-110, if applicable). Coatings and lining shall be in accordance with section 2.2.8 of the Specifications.

2.1.3.4 Service Connections. Service connections shall be made by means of a bronze service clamp, manufactured specifically for use with C-900 or C-905 PVC pipe and appropriate corporation stops.

2.2 DUCTILE IRON PIPE

These specifications cover ductile iron pipe (3-inch diameter and greater) to be used in water transmission and distribution systems with mechanical joints, rubber ring slip type joints or flanged joints.

2.2.1 General. Ductile iron pipe shall be designed in accordance with AWWA and for pressures and conditions as stated in these specifications or called for on the plans. Ductile iron pipe shall conform to AWWA C-151.

2.2.2 Minimum Nominal Thickness. The specified thickness will be determined for the given internal and external loading requirements in accordance with AWWA C-150. The class of pipe, wall thickness, and coatings required will be shown on the plans or the bid form and/or as specified herein for all ductile iron pipe installation.

2.2.3 River Crossing Pipe. River crossing pipe shall be ductile iron, Flex-Lok as manufactured by the American Cast Iron Pipe company or equal conforming to the appropriate requirements of AWWA C150/ANSI A21.50 and AWWA C151/ANSI A21.5 with a minimum thickness class of 54.

2.2.4 Lengths. Pipe may be furnished in 12, 16, 16 1/2, 18 or 20 feet nominal laying lengths.

2.2.5 Marking. The net weight, class or nominal thickness and sampling period shall be marked on each pipe.

2.2.6 Underground Marking for DI Pipe. Underground marking for pipe shall be both tracing wire and marking tape.

2.2.6.1 *Underground Tracer Wire*. A detectable underground tracer wire shall be placed in the trench directly on top of the pipe. Wire shall be taped to the top of the pipe. The wire used shall be 12 AWG solid HDPE 30 MIL copper conductor with a 30 mil thick, high-density, high molecular weight polyethylene (HDPE) insulation and rated for 30 volts. Extreme care shall be exercised in splicing wire ends to assure continuity. Wire nuts designed specifically for buried service shall be used at all splices. At each valve box the wire shall be looped to the surface extending 12 inches above the concrete valve box pad (see Std. Dwg. for valve). When the entire project or pipeline segment is complete, including meter installation and leak repairs, the locating wire system shall be checked for continuity. Tracer wire to be provided by Pro-Line Safety Products, or approved equal. Wire insulation color shall be blue.

2.2.6.2 *Underground Marking Tape*. A detectable underground marking tape shall be placed in the trench approximately 12 inches below the finished grade. The tape used shall be laminated aluminum foil with the printing “CAUTION - Buried Water Line Below”. Printing shall be readable through the clear poly lamination and surface printing is not acceptable. Tape size shall be 2 inch width as provided by Presco Products, or approved equal. Color of the tape shall be blue.

2.2.7 Pipe Joints for Ductile Iron Pipe. Joints for buried pipe shall be either mechanical joint or push-on joint conforming to the requirements of AWWA C-111. Mechanical joint bolts and nuts shall be the low-alloy steel type conforming to AWWA C-111.

Interior piping of vaults, plants, etc. shall be supplied with flanged joints meeting the requirements of AWWA C-115. Special joints, such as the “locked” or “restrained” type, shall be as shown on the plans and/or called for in the bid schedule.

Gaskets resistant to hydrocarbon penetration shall be used within 200 feet of underground fuel tanks, gas lines, and/or oil transport lines. The gaskets shall be approved by the Engineer.

2.2.8 Coatings and Lining. All buried ductile iron pipe shall have manufacturers outside coal tar or asphaltic base coating and a cement lining and bituminous seal coat on the inside. Cement mortar lining and a bituminous seal coat inside shall conform to AWWA C-104 latest revision.

Where specifically called for on the plans, pipe and fittings housed and in vaults shall be lined and coated on the inside as specified herein for buried ductile iron pipe and fittings, but the exterior shall be proved with a red primer coat. Pipe penetrating from the interior of vaults to the exterior shall be coated with coal tar epoxy.

2.2.9 Fittings for Ductile Iron Pipe. Ductile iron mechanical, push-on and flanged joints shall conform to AWWA C-153 (C-110, if applicable) for centrifugally cast iron water pipe. Mechanical joints shall also conform in all respects to AWWA C-111. All fittings shall be manufactured for the size and pressure class of the pipeline in which they are to be used. All fittings shall be furnished complete with all joint accessories. All ductile iron pipe fittings for water, sewer, air, gas and force main service shall be coated outside and lined on the inside the same as the line on which they are installed.

2.2.10 Locking Gaskets. Restrained joint ductile iron pipe shall utilize push on gaskets such as Fast Grip, Field Lok, Sure Stop, or approved equal.

2.3 POLYETHYLENE PIPE

This pipe is used primarily for stream crossings and other special applications in locations indicated on the Drawings. The required pressure class shall be as shown on the Drawings.

The pipe shall be PE 3408 high density, high molecular weight polyethylene pipe equal to DRISCOPIPE 1000 as manufactured by Phillips Driscopipe, Inc. The pipe shall meet or exceed the following specifications:

a. ASTM 3350 having a cell classification of PE34534C
b. ASTM F714 - Dimensions and Workmanship
c. AWWA C901 - Potable Water Pipe
d. ASTM D1248 - Type III, Class C, Category 5, Grade P34
e. ASTM D3261 - Fittings Standard
f. NSF - Listed, Standard #14

The pipe shall be joined by the butt fusion technique utilizing controlled temperatures and pressures to produce a fused, leak-free joint that has equal or greater strength than the pipe itself in both tension and hydrostatic loading. The joining system shall be equal to Phillips butt fusion joint system.

Transitions to the continuing pipeline shall be made with the appropriate fittings to maintain the integrity of the piping system as recommended by the pipe manufacturer.

Drawings showing details of the installation shall be submitted to the Engineer for approval prior to installation.

3.0 EXECUTION

3.1 HAULING AND STORAGE

The Contractor shall notify the Engineer when pipe will be received on the job so that proper arrangements may be made for inspecting the unloading and stringing, as well as inspecting and examining the pipe materials.

All pipe shall be covered with tarpaulin during hauling from the manufacturer to the job site. It is acceptable for the front end only to be covered. The intent is to prevent diesel exhaust residue from coating the pipe and/or contaminating the gaskets.

Care must be exercised in the handling of all materials and equipment. The Contractor will be held responsible for all breakage or damage to items caused by his workmen, agents, or appliances for handling or moving. Pipes and other castings shall in no case be thrown or dropped from cars, trucks, or wagons to the ground, but shall be lowered gently and not allowed to roll against or strike other castings and unyielding objects violently.

Valves, castings, fabricated metal, reinforcing steel, etc. shall be yarded or housed in some convenient location by the Contractor and delivered at the construction site as required. All equipment and materials subject to damage from the weather, dampness, changes in temperature, or exposure shall be protected by a dry, weatherproof enclosure until ready for installation or use. The cost of all hauling, handling, and storage shall be included in the prices bid for equipment and materials in place. The Owner takes no risk or responsibility for fire, flood, theft, or damage until after the final acceptance of the work.

3.2 LINES AND GRADES

The Contractor will be required to accomplish any detailed layout, including that required for establishing the grade of the pipe line.

3.3 TRENCH EXCAVATION

3.3.1 General. This section describes the acceptable methods of trenching for the installation of pressure pipe and casing pipe in an open trench.

Trenching may be accomplished by excavator, backhoe, trenching machine or by hand depending on the construction area.

At the Contractor's option, trenching, by a trenching machine, excavator, or by backhoe is acceptable except as noted below:

Where the pipe line is being constructed close to other utilities, structures, building, or large trees, and it is reasonable to anticipate possible damage from the use of powered excavation equipment, then trenching shall be made by hand methods.

The Contractor shall include in his unit price bid, all trenching necessary for installation of all pipelines as planned and specified. Trenching shall include all clearing and grubbing, including all weeds, briars, trees, stumps, etc. encountered in the trenching. The Contractor shall dispose of any such material by burning, burial, or hauling away (or as noted on the drawings), at no extra cost to the Owner. It shall be the Contractor's responsibility to notify the appropriate State and local Air Pollution Control agencies when he conducts open burning of refuse. Ornamental shrubs shall be removed, protected, and replanted. Trenching also includes such items as minor street, road, sidewalk, pipe and small creek crossings, and cutting, moving or repairing damage to fences, poles, gates and/or other surface structures regardless of whether shown on the plans.

The Contractor shall protect existing facilities against danger or damage while pipeline is being constructed and backfilled, or from damage due to settlement of this backfill. In case of damage to any existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structures will be in as good condition and serve its purpose as completely as before and such restoration and repair shall be done without extra cost to the Owner. The use of trench-digging machinery will be permitted except where its operations will cause damage to trees, buildings or existing structures above or below the ground. At such locations hand methods shall be employed to avoid such damage. All excavated material shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

All excavation shall be open trenches, except where the drawings call for tunneling, boring, or jacking under structures, railroads, sidewalks and roads. The construction procedure for these types of excavation is described elsewhere in these specifications.

All trench excavation shall be termed unclassified and costs shall be included in the unit price bid for the pipe.

3.3.2 Clearing. The Contractor shall accomplish all clearing and/or grubbing as required for the construction under this contract. Clearing and grubbing shall include the cutting and removal of trees, stumps, brush, roots, logs, fences and other loose or projecting material and natural obstructions which, in the opinion of the Engineer, must be removed to properly construct and operate the facilities. Ornamental shrubs, plantings, fences, walls, etc. shall be removed and replanted or replaced or protected from the construction activity. Clearing and/or grubbing shall be incidental to the various bid items and no additional compensation will be paid for these activities.

3.3.3 Trench Depth. Trenches shall be excavated to the line and grade required for the installation of pipe at the elevations indicated on the plans. The minimum depth of cover shall be 30 inches above the top of the pipe, unless shown otherwise on the plans or on the Standard Details. When the pipe is laying in or on solid rock, the minimum depth of cover shall also be 30 inches above the top of the pipe. No additional compensation will be made for extra depth where required by the plans or due to Contractor error. Excavation, except as required for exploration, shall not begin until the proposed work has been staked out. Materials which are not required for backfill and site grading shall be removed and disposed of as directed by the Engineer. Hauling, bedding, and backfilling shall be considered incidental to the various bid items and will not be paid for directly. Excavation shall be of sufficient depth to allow the piping to be laid on the standard pipe bedding in accordance with Section 3.4. The trenches shall be excavated to a minimum of six inches below the bottom of the pipe barrel in rock. In all cases where lines are under traffic, a minimum cover of forty-two inches (42") shall be provided. Should it be necessary to avoid existing utilities, culverts, outlets, or other structures, the water line shall be carried deeper at no additional expense to the Owner.

Where the plans call for extra trench depth, this extra depth shall be provided at no extra cost.

3.3.4 Trench Width. Trench widths shall meet or exceed the minimum width that will provide free working space on each side of the pipe and to permit proper backfilling around the pipe as shown in the accompanying table and unless specifically authorized by the Engineer, shall not be excavated to wider than two feet (2') plus the nominal diameter of the pipe at the top of the trench. Before laying the pipe, the trench shall be opened far enough ahead to reveal any obstruction that may necessitate changing the line and grade of the pipe. Should the Contractor fail to accomplish this, and changes are required, they shall be at his sole expense. In rock, all ledge rocks, boulders and large stones shall be removed to provide eight inches (8") of clearance on each side and below all pipe and fittings.

Minimum Trench Width

Size	Width
Up to 4"	1'-6"
6" Pipe	2'-0"

Size	Width
15" Pipe	2'-8"
16" Pipe	2'-8"

8" Pipe	2'-0"
10" Pipe	2'-4"
12" Pipe	2'-6"
14" Pipe	2'-6"

18" Pipe	3'-0"
20" Pipe	3'-2"
21" Pipe	3'-4"
24" Pipe	3'-8"

3.3.5 Shoring, Sheeting, and Bracing of Excavation. Where unstable material is encountered, or where the depth of the excavation in earth exceeds five feet (5'), the sides of the trench or excavation shall be supported by substantial sheeting, bracing, or shoring. The design and installation of all sheeting, sheet piling, bracing or shoring shall be based on computations of pressure exerted by the materials to be retained under retaining conditions. Adequate and proper shoring of all excavations will be the entire responsibility of the Contractor. The Standards of the Federal Occupational Safety and Health Act and the Kentucky Department of Labor shall be followed.

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

3.3.6 Removal of Water. The Contractor shall provide for adequate removal of all water and the prevention of surface water from entering the excavation. The Contractor shall maintain dry conditions within the excavations until the backfill is placed. No additional compensation will be paid for replacement and/or stabilization of prepared excavations due to flooding and/or deterioration from extended exposure. All water pumped or drained from the excavation shall be disposed of in a suitable manner without damage to adjacent property or to other work under construction.

3.3.7 Pavement Removal. Pavement removal shall be as indicated on the plans or directed by the Engineer. When so required, or when directed by the Engineer, only one-half (1/2) of the street crossings or road crossings shall be excavated before placing temporary bridges over the side excavated, for the convenience of the traveling public. All backfilled ditches shall be maintained in such a manner that they will offer no hazard to the passage of traffic. The convenience of the traveling public and the property Owners abutting the improvements shall be taken into consideration. All public or private drives shall be promptly backfilled or bridged at the direction of the Engineer. Pavement replacement shall be in accordance with Section 02513 of these specifications. Excavated materials shall be disposed of so as to cause the least interference and in every case the disposition of excavated materials shall be satisfactory to the Engineer.

3.3.8 Traffic Maintenance. The Contractor shall be held responsible for any damage that may occur to persons or property by reason of the failure of the Contractor to properly guard and flag all open trenches or obstructions along the routes of the water lines. The Contractor, at his own expense, shall maintain warning signs, barricades and watchmen or flag men to control traffic at such times as his work would interfere with the flow of traffic. No excavation shall begin that may present a safety hazard unless the signs, barricades, lights, etc. are available to protect the open excavation at the conclusion of the day. The Contractor shall comply with all Federal and State

Occupational Safety and Health requirements for this type of construction. The Contractor shall also comply with all local and Kentucky Department of Highways requirements for signing and traffic control.

3.3.9 Line Location. The location of pipelines and their appurtenances as shown are those intended for the final construction. However, conditions may present themselves before construction on any line is started that would indicate desirable changes in location. In such cases, the Owner reserves the right to make reasonable changes in line and structure locations without extra cost, except as may be determined by extra units of materials and construction actually involved. The Owner is under no obligation to locate pipelines so they can be excavated by machine.

3.4 BEDDING OF PIPELINE

In all cases the foundation for pipe shall be prepared so that the entire load of the back-fill on top of the pipe will be carried uniformly on the barrel of the pipe. The bells of the pipe shall not carry any of the load of the backfill. The Contractor should refer to the Standard Details for pipe bedding shown in the plans. The bedding specifications shall govern the backfill from the bottom of the trench up to the centerline or spring line of the pipe.

3.4.1 Stable Earth Foundation. On all PVC pipelines, the trench bottoms shall be smooth and free of frozen material, clodded dirt and stones over 1/2" diameter. Bottom dirt left by trenching equipment will usually provide adequate material to level the trench bottom and provide bedding support for the pipe barrel. If the trench bottom is free of dirt, soft material may be shoveled off the side walls or shoveled under the pipe to insure proper pipe barrel bedding. In areas where the trench bottom is hard, a layer of soft backfill must be provided to insure the pipe barrel is properly cushioned. See the plans for proper bedding material depth.
If the foundation is good firm earth the pipe may be laid directly on the undisturbed earth provided the pipe barrel is supported for its full length.

Bedding of No. 9 stone, fine gravel, sand or compacted finely graded select earth shall be used to correct irregularities in the subgrade.

As an alternative to the above method, excavation may be undercut to a depth below the required invert elevation that will permit laying the pipe on a bed of granular material or finely graded select earth to provide continuous support for the pipe barrel. Bedding depth shall be as shown on the plans.

The bedding is not a separate pay item and shall be included as incidental expense in the unit price for the pipe bid per foot of pipe.

3.4.2 Trenches in Rock. All installation in rock will utilize the undercutting method. Bedding will be with 6 inches crushed stone or suitable earth material. Bedding will be

provided at no additional cost. Costs for the bedding shall be included in the unit price for the pipe.

3.5 PIPE LAYING

3.5.1 General. Proper instruments, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. Each pipe manufacturer shall have an experienced representative on the job for at least one day at the commencement of jointing and laying operations.

Before any length of pipe is placed in the trench, a careful inspection shall be made of the interior of the pipe to see that no foreign material is in the pipe. In order to properly remove any foreign materials, a swab of necessary length is to be available at all times.

All pipe shall be lowered carefully into the trench, properly aligned and properly jointed by use of suitable tools and equipment, in such a manner as to prevent damage to pipe materials and protective coatings and linings. Excessive scratching of the exterior surface of the pipe will be cause for rejection of the pipe.

Under no circumstances shall pipeline materials be dropped or dumped into the trench. The pipe and fittings shall also be inspected for the purpose of determining if they are sound and free from cracks. Laying of pipe shall be commenced immediately after excavation is started. Pipe shall be laid with bell ends facing in the direction of laying.

When pipe laying is not in progress, the open ends of pipe shall be closed by approved means to prevent entrance of trench water into the line. Whenever water is excluded from the interior of the pipe, adequate backfill shall be deposited on the pipe to prevent floating. Any pipe which has floated shall be removed from the trench and re-laid as directed by the Engineer. No pipe shall be laid in water or on frozen trench bottom, or whenever the trench conditions or the weather are unsuitable for such work.
If any defective pipe and fittings shall be discovered after the pipeline is laid, they shall be removed and replaced with a satisfactory pipe or fitting without additional charge to the Owner. Open ends of unfinished pipe lines shall be securely plugged or closed at the end of each day's work or when the line is left temporarily at any other time.

3.5.2 Laying Ductile Iron Pipe. Ductile iron pipe shall first be thoroughly cleaned at joints, then joined according to instructions and with tools recommended by the manufacturer. Three (3) copies of instructions shall be furnished to the Engineer and one (1) copy shall be available at all times at the site of the work. The lining inside ductile iron pipe must not be damaged by handling.

All pipes must be forced and held together, or "homed" at the joints, before sealing or bolting. Pipe must be aligned as each joint is placed, so as to present as nearly true, straight lines and grades as is practical, and all curves and changes in grades must be laid in such a manner that the manufacturer's recommended maximum deflection is not exceeded at any joint.

Cutting of pipe may be done by wheeled pipe cutters or saws as the Contractor may elect, but the Contractor will be held responsible for breakage or damage caused by careless cutting or handling.

All ductile iron pipe shall be installed per AWWA C150 Laying Condition Type 3 unless otherwise noted, six inches (6”) crushed stone bedding or suitable earth shall be used in rock. No pipe shall be laid resting on rock, blocking, or other unyielding objects. Jointing before placing in trench, and subsequent lowering of more than one section jointed together may be allowed, subject to the Engineer approval and direction.

When using pipe with push-on joints, care must be exercised to make certain that the correct gasket is being used for the type of joint installed and that the gasket faces the proper direction. Before inserting the gasket, the groove and bell socket should be carefully cleaned of all dirt. If sand or dirt is permitted to remain in the groove, leaks will occur. Lubricant must be applied to bell socket, gasket and plain-end of pipe as required by manufacturer. Plain-end must be beveled before joint is made. Deflection required at the joint shall be obtained after the joint is made.

3.5.3 Laying Plastic Pipe. The trench bottom must be smooth and uniform and the alignment must conform to the plans. Bedding and cover as specified herein and shown in the Standard Details is required.

To make a clean and unobstructed joint, it is necessary to wipe the ring, groove and pipe spigot free from all foreign materials at the time of assembly. The ring must be positioned properly in the fitting to receive the pipe by a worker who is not in contact with the lubricant. In general, the lubricant is applied to the spigot (not the ring or groove). However, the manufacturer's instructions are to be followed in all cases. Only an approved lubricant may be used in accordance with the manufacturer's recommendations. All plastic pipe shall be joined by hand.

Where good bedding conditions are obtained, PVC pipe smaller than 4 inches may be assembled outside the trench in longer sections (as conditions allow) and then lowered into the trench. At any time when improper bedding is discovered or the pipe is severely deflected the pipe will be removed from the trench and the condition corrected. Pipe in sizes 4 inch and above may be assembled outside the trench but must be lowered into the trench as each joint is assembled. Regardless of installation methods all joints must be inspected after laying in trench for proper insertion and alignment. Field cuts and bevels will be allowed in accordance with the manufacturer's recommendations for these operations. A new reference mark shall be installed before joining any field cut pipe. The same requirements for clearance from rock or other objects, thrust blocking and deflections shall apply to PVC pipe as for other pipe materials.

C-900 PVC pipe of all sizes must be assembled in the trench in strict accordance with the manufacturer's requirements.

3.5.4 Installation of River Crossing Pipe. The crossing pipe shall be assembled and installed in accordance with manufacturer's recommendations. Installation shall be made at time of low flow, using cofferdams as necessary to divert stream flow. The crossing pipe shall be laid and allowed to settle before joining to the pipe on each side of the stream. The crossing pipe shall be tested separately once in place to detect any leaks or bad joints. After connecting to the land pipe, it shall be tested the same as specified for the other water mains. See the DRAWINGS for additional installation requirements.

3.6 BACKFILLING

Backfilling must be started as soon as practicable after pipe has been laid. The Engineer shall be given a minimum of 8 hours for inspection before backfilling. The backfill shall be crushed rock, sand, or finely divided earth free from debris, organic material and stones, places simultaneously on both sides of pipe to the same level by hand.

In backfilling of the lower part of the trench beginning at the top of the bedding, the backfill material shall be carefully selected and walked-in around the pipe in 6” layers to a point 8 inches higher than the top of the pipe. The filling of the trench and the tamping of the backfill shall be carried on simultaneously on both sides of the pipe in such a manner that the completed pipe line will not be disturbed and injurious side pressures do not occur.

After the above specified backfill is hand placed, rock may be used in the backfill in pieces no larger than 18 inches in any dimension and to an extent not greater than one-half (1/2) the backfill materials used. If additional earth is required, it must be obtained and placed by the Contractor. Filling with rock and earth shall proceed simultaneously, in order that all voids between rocks may be filled with earth. Above the hand placed backfill, machine backfilling may be employed without tamping, (if not contrary to specified conditions for the location) provided caution is used in quantity per dump and uniformity of level of backfilling. Backfill material must be uniformly ridged over trench and excess hauled away, with no excavated rock over 1-1/2 inches in diameter or pockets of crushed rock or gravel in top 6 inches of backfill. Ridged backfill shall be confined to the width of the trench and not allowed to overlap onto firm original earth and its height shall not be in excess of needs for replacement of settlement of backfill. All rock, including crushed rock or gravel from construction, must be removed from yards and fields. Streets, roadways and walks shall be swept to remove all earth and loose rock immediately following backfilling.

In the case of street, highway, railroad, sidewalk and driveway crossings or within any roadway paving or about manholes, valve and meter boxes, the backfill must be machine tamped in not over 4-inch layers, measured loose in accordance with the standard details. Where backfill is under paved driveways, streets, highways, railroads, sidewalks, paved parking areas and other areas where settlement is not allowed,

crushed stone or coarse sand backfill only shall be used up to the paving surface. Crushed stone shall be Kentucky Department of Highways Standard Specification No. 57. Coarse sand backfill shall be spread in layers not over 4 inches thick and thoroughly compacted. Sand may be moistened to aide compaction. Tunnels shall be backfilled in not over 3-inch layers, measured loose, with selected material suitable for mechanically tamping. If material suitable for tamping cannot be obtained, sand, gravel or crushed rock shall be blown, packed or sluiced to completely fill all void spaces.

Where local conditions permit, pavement shall not be placed until 30 days have passed since placing backfill. Crushed stone is specified for roads and parking areas and sidewalks or their bases, shall be placed and compacted to the top of trench. Backfills shall be maintained easily passable to traffic at original ground level, until acceptance of project or replacement of paving or sidewalks.

Where the final surfacing is to be crushed stone, compacted earth backfill may be used in the trench to within 6 inches of the top as shown in the Standard Details.

The Kentucky Transportation Cabinet requires that water and sewer lines—when placed within the limits of the roadway embankment and/or beneath the roadway itself—be backfilled with sand, limestone sand (11's or smaller), or "flowable fill" as defined by Section 601.03.03.B(5) of their "Standard Specifications for Road and Bridge Construction". The Cabinet typically requires that sand, limestone sand, or flowable fill be used to backfill the trench and/or bore pit up to the subgrade elevation and extending to the outside edge of the shoulder.

Railroad Company and Highway Department requirements in regard to backfilling will take precedence over the above general specification where they are involved.

The Contractor shall protect all sewer, gas, electric, telephone, water and drain pipes or conduits, power and telephone poles and guy wires from danger of damage while pipelines are being constructed and backfilled, or from danger due to settlement of his backfill.

In case of damage to any such existing structures, repair and restoration shall be made at once and backfill shall not be replaced until this is done. In all cases, restoration and repair shall be such that the damaged structure will be in as good condition and serve its purpose as completely as before uncovering and such restoration and repair shall be done without extra charge.

No extra charge shall be made for backfilling of any kind, except as provided in the Bid. Backfilling shall be included as a part of the unit price bid for which it is subsidiary. No extra charge shall be made for supplying outside materials for backfill.

Before completion of contract, all backfills shall be reshaped, holes filled and surplus material hauled away, and all permanent walks, street, driveway and highway paving, and sod, replaced and reseeding performed.

The Contractor shall be responsible for clean-up, grading, seeding, sodding or otherwise restoring all areas that he disturbs.

Any deficiency in the quantity of material for backfilling the trenches or for filling depressions caused by settlement, shall be supplied by the Contractor.

3.7 TIE-INS TO EXISTING PIPELINES

This work shall consist of connecting new water pipes to the existing system where shown on the plans and shall include the necessary fittings, tapping sleeves, valves and necessary equipment and material required to complete the connection.

Knowledge of pipe sizes in the existing system may not be accurate, therefore, it is recommended that the Contractor check outside diameters of existing pipe and types of pipe prior to ordering the required accessories. No additional payment will be allowed for matching pipe and/or accessories when the proper size is not ordered.
Neither the Owner nor the Engineer can guarantee the location of the existing lines. The Contractor shall verify the location of all existing water mains and valves pertaining to the proposed improvements before excavation is started.

The necessary regulation or operation of the valves on existing mains, to allow for the connections being made, shall be supervised by the Engineer or Engineers' Representative. Before shutting down an existing water main or branch main for a proposed connection, prior approval for a specific time and time interval shall be obtained from a representative of the Owner. At no time shall an existing main be shut down without the Owner's knowledge and permission.

Excavation to existing water mains shall be carefully made, with care being exercised not to damage the pipe. The excavation shall not be of excessive size or depth beneath the pipe. The sides of the excavation shall be as nearly vertical as possible.

The Contractor shall be responsible for any damage to the existing system and any such damage shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

The Contractor shall verify, by field inspection, the necessary sizes, lengths and the types of fittings needed for each inter-connection. Typical connections are shown on the plans and any modifications or changes shall be subject to the approval of the Engineer. The exact length of the proposed water main needed for this work shall also be determined by field measurement as required.

The probing required to locate existing mains is not a separate pay item.

3.8 PIPE ENTERING STRUCTURES

Ductile iron, steel, or PVC pressure pipe, 4-inch diameter or larger, entering a structure below original earth level, unsupported by original earth for a distance of more than six feet (6'), shall be supported by #57 crushed stone. Costs for the support shall be included in the unit price for the pipe.

3.9 OWNERSHIP OF OLD MATERIALS

All piping, fittings, valves, hydrants and other appurtenances that are removed as a result of new construction shall be removed by the Contractor but shall become the property of the Owner. All such items shall be delivered to a point by the Contractor. Said point shall be on the Owner's property and shall be designated by the Owner or Engineer.

3.10 THRUST BLOCKS AND ANCHORAGE

Thrust blocks shall be installed whenever the pipe line changes direction, as at tees, bends, crosses, stops, as at a dead end; or at valves. The locations of thrust blocks depend on the direction of thrust and type of fitting. Their size and type depends on pressure, pipe size, kind of soil, and the type of fitting. Where thrusts act upward (as at vertical curves) the weight of the pipe, the water in the pipe and the weight of the soil over the pipe should be determined to make certain that the total weight is sufficient to resist upward movement. If there is not enough soil or if it will not compact over the pipe or it is too soft to resist movement, then ballast or concrete may be placed around the pipe in sufficient weight and volume to counteract the thrust. Where a fitting is used to make a vertical bend, the fitting may be anchored to a concrete thrust block designed to key in to undisturbed soil and to have enough weight to resist upward and outward thrust, since the newly placed backfill may not have sufficient holding power.

Thrust blocks shall be constructed of not less than 3,000 psi concrete conforming to KTC Specification 601 and placed between the fitting and the trench wall. It is important to place the concrete so it extends to undisturbed (freshly cut) trench wall.

3.11 MAINTENANCE OF FLOW OF DRAINS AND SEWERS

Adequate provision shall be made for the flow of sewers, drains and water courses encountered during construction. Any structures which are disturbed shall be satisfactorily restored by the Contractor.

3.12 INTERRUPTION OF UTILITY SERVICES

No valve, switch or other control on any existing utility system shall be operated for any purpose by the Contractor without approval of the Engineer and the Utility. All consumers affected by such operations shall be notified by the Contractor as directed by the Engineer and utility before the operation and advised of the probable time when service will be restored.

3.13 FENCING

Where water supply line is being constructed in fields where livestock is being grazed, Contractor shall provide temporary fence as approved by the Engineer around open trenches to prevent livestock from falling in trenches. Where trenching operations should isolate grazing stock from their source of water, Contractor will either provide temporary bridging over trench or else provide water for such stock.

Where trench crosses near sound existing corner posts and existing fence is in good condition, fence may be taken loose, rolled back and stored until pipe line is completed at this point, then replaced. Additional posts will be provided and additional new fence shall be provided when it is necessary to place the fence crossed by the water line in a condition equal to existing fence before water line was constructed.

Where it is necessary to cut existing fence, new end posts shall be installed on each side of the water line and the old fence thoroughly fastened to these new posts before cutting. After pipe line is completed at this point, a new fence of galvanized wire (No. 9 gauge with No. 11 filler wires) shall be stretched between these new end posts and thoroughly fastened to existing posts and any new intermediate posts necessary to provide a good fence. Replacement of all fences shall be on a replacement in-kind basis, and shall be considered incidental to laying of the lines and any additional cost shall be included in the unit price bid per lineal foot of pipe.

3.14 PROTECTION OF ADJACENT LANDSCAPE

Reasonable care shall be taken during construction of the water lines to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be temporarily tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

In the course of construction, the Contractor may deflect horizontal alignment of the water line to avoid trees and to keep from damaging their roots. The Contractor shall be fully responsible for settling all claims by private property owners concerning damage to trees and shrubs.

3.15 COORDINATION WITH UTILITIES

Prior to construction, the Contractor shall arrange to meet with representatives of all utilities, and provide them with his anticipated work schedule. The Contractor shall have the utilities make their best determination of utility locations in the areas in which he is working. Throughout the progress of the work, such field markings of utilities shall be kept current.

Repairs to any utilities damaged by the Contractor shall normally be performed by the utility at the Contractor's expense, unless the Contractor and the utility negotiate other understandings and/or procedures.

3.16 BLASTING AND ROCK EXCAVATION

The Contractor shall make his own investigation as he deems necessary to ascertain the sub-surface conditions to be encountered in the work.

All blasting operations shall be conducted in accordance with municipal ordinances, state and federal laws and Section 9, Explosives, of the "Manual of Accident Prevention in Construction", published by the Associated General Contractors of America, Inc. Soil particle velocity shall not exceed limit set by Kentucky law. All explosives shall be stored in conformity with said ordinances, laws and safety regulations. No blasting shall be done within five feet of any water mains, sewer lines, natural or manufactured gas lines, liquid petroleum product lines or other utilities. Any damage done by blasting is the responsibility of the Contractor and shall be promptly and satisfactorily repaired by him.

The Contractor shall use delay caps or other approved methods to reduce earth vibrations and noise. Mud capping, as defined in the above manual, will not be permitted as a method of breaking boulders. No blasting shall be permitted on Sundays or after dark.

Prior to commencing with the work, the Contractor shall, during a preconstruction conference with the Owner and the Engineer, state clearly his approach to performing the excavations on the project. He shall be familiar with the laws and ordinances covering blasting and shall also give consideration to the use of hydraulically operated rock breaking devices in lieu of blasting where considered necessary. If blasting is not handled in an expert manner at all times, the Engineer reserves the right to suspend blasting and require the work to proceed without it.

Prior to blasting, the Contractor shall make his own detailed preblast survey of adjacent walks, curbs, retaining walls, house foundations, etc. to determine conditions prior to the work. Such a file of information, including photographs, may be certified in such a manner as the Contractor believes necessary since this information that may stand in his defense.

4.0 PAYMENT

Payment for supplying, transporting and storing pipe, trenching, standard bedding, pipe installation, fittings, thrust-blocking, pipe locating wire and tape, testing, backfilling (including flowable fill, if required), disinfection, seeding, crop damage, regular stream crossings, clean-up, tie-ins to other structures and other incidental items in this section shall be included in the work which it is subsidiary in the Bid Schedule. No separate payments shall be made for water lines.

END OF SECTION

SECTION 13103

TESTING AND STERILIZATION

1.0 TESTING

1.1 After pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure test of at least 1.5 times the working pressure at the point of testing, but in no case less than that required by other sections herein. In addition, a leakage test shall be conducted concurrently with the pressure test.

1.2 PRESSURE TEST

1.2.1 Test pressure shall:

1.2.1.1 Not be less than 1.25 times the working pressure at the highest point along the test section.

1.2.1.2 Not exceed pipe or thrust restraint design pressures at the lowest point along the test section.

1.2.1.3 Be of at least six (6) hour duration unless otherwise stipulated by owner.

1.2.1.4 Not vary by more than plus or minus 5 psi.

1.2.1.5 Not exceed twice the rated pressure of the valves or hydrants when the pressure of the test section includes closed gate valves or hydrants.

1.2.1.6 Not exceed the rated pressure of resilient seat butterfly valves when used.

1.2.2 Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer.

1.2.3 Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged, or left in place at the discretion of the Engineer.

1.2.4 All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves or hydrants that are

discovered following the pressure test shall be repaired or replaced with sound material and the test shall be repeated until it is satisfactory to the Engineer.

1.3 LEAKAGE TESTING

1.3.1 Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

1.3.2 No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

L = ND(P exp 1/2)/133,200

in which L is the allowable leakage, in gallons per hour; N is the length of pipeline tested in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

1.3.2.1 Allowable leakage at various pressures is shown in TABLE K-1.

1.3.2.2 When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed.

1.3.2.3 When hydrants are in the test section, the test shall be made against the closed hydrant.

1.3.3 Acceptance shall be determined on the basis of allowable leakage. If any test of pipe laid discloses leakage greater than that specified in Section 1.3.2 the contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance.

1.3.3.1 All visible leaks are to be repaired regardless of the amount of leakage.

Table K-1
Allowable Leakage per 1,000 Ft. Of Pipeline (GPH)

Avg. Test Pressure (psi)	Nominal Pipe Diameter (Inches)								
	2	3	4	6	8	10	12	14	16
450	0.32	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55
400	0.30	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40
350	0.28	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25
300	0.26	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08
275	0.25	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90

225	0.23	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47
125	0.17	0.25	0.34	0.50	0.67	0.84	0.01	1.18	1.34
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20

Avg. Test Pressure (psi)	Nominal Pipe Diameter (Inches)							
	18	20	24	30	36	42	48	54
450	2.87	3.18	3.82	4.78	5.73	6.69	7.65	8.60
400	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225	2.03	2.35	2.70	3.38	4.05	4.73	5.41	6.03
200	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

2.0 STERILIZATION (NOT REQUIRED ON RAW WATER LINES)

2.1 GENERAL

It is the intent of this section to present essential procedures for disinfecting new and repaired water mains. Sterilization is required on all potable water lines and within any potable water structures, or as directed by the engineer. The section is patterned after AWWA C651 and AWWA C652. The basic procedure comprises:

2.1.1 Preventing contaminating materials from entering the water mains during construction or repair and removing by flushing materials that may have entered the water main.

2.1.2 Disinfecting any residual contamination that may remain.

2.1.3 Determining the bacteriologic quality by laboratory test after disinfection.

2.2 PREVENTIVE MEASURES DURING CONSTRUCTION

2.2.1 Precautions shall be taken to protect pipe interiors, fittings, and valves against contamination. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material. When pipe laying is not in progress, as, for example, at the close of the day's work, all openings in the pipe line shall be closed by water tight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

If dirt, that, in the opinion of the Engineer, will not be removed by the flushing operation (section 2.3) enters the pipe, the interior of the pipe shall be cleaned and swabbed as necessary, with a five (5%) percent hypochlorite disinfecting solution.

2.2.2 Joints—No contaminated material or any material capable of supporting prolific growth of micro-organisms shall be used for sealing joints. Material shall be handled in such a manner as to avoid contamination. Where applicable, materials must conform to AWWA standards. The lubricant used in the installation of sealing gaskets shall be suitable for use in potable water. It shall be delivered to the job in enclosed containers and shall be kept clean.

2.3 PRELIMINARY FLUSHING

The main shall be flushed prior to disinfection unless disinfected by the method in section 2.4.2.1. It is recommended that the flushing velocity be not less than 2.5 ft/sec. The rate of flow required to produce this velocity in various diameters is shown in Table K-2. No site for flushing should be chosen unless it has been determined that drainage is adequate at the site.

Table K-2
Required Openings To Flush Pipelines
(40-PSI Residual Pressure)

Pipe Size (in)	Flow Required to Produce 2.5 fps Velocity (gpm)	Orifice Size (in)	Hydrants Required	
			Number of Hydrants	Nozzle Size (In)
4	100	15/16	1	2 1/2
6	220	1 3/8	1	2 1/2
8	390	1 7/8	1	2 1/2
10	610	2 5/16	1	2 1/2
12	880	2 13/16	1	2 1/2
14	1,200	3 1/4	2	2 1/2
16	1,565	3 5/8	2	2 1/2
18	1,980	4 3/16	2	2 1/2

2.4 FORM OF CHLORINE FOR DISINFECTION

The most common forms of chlorine used in the disinfecting solutions are liquid chlorine (gas at atmospheric pressure), calcium hypochlorite granules, and sodium hypochlorite solutions.

2.4.1 Liquid Chlorine

2.4.1.1 *Use*: Liquid chlorine shall be used only when suitable equipment is available and only under the direct supervision of a person familiar with the physiological, chemical, and physical properties of this element and who is properly trained and equipped to handle any emergency that may arise. Introduction of chlorine-gas directly from the supply cylinder is unsafe and shall not be permitted.

NOTE: The preferred equipment consists of a solution fed chlorinator in combination with a booster pump for injecting the chlorine-gas water mixture into the main to be disinfected. Direct feed chlorinators are not recommended because their use is limited to situations where the water pressure is lower than the chlorine cylinder pressure.

2.4.2 Hypochlorites

2.4.2.1 *Calcium Hypochlorite*: Calcium hypochlorite contains seventy (70%) percent available chlorine by weight. It is either granular or tabular in form. The tablets, 6-8 to the ounce, are designed to dissolve slowly in water. Calcium hypochlorite is packaged in containers of various types and sizes ranging from small plastic bottles to one hundred (100) pound drums.

A chlorine-water solution is prepared by dissolving the granules in water in the proportion requisite for the desired concentration.

2.4.2.2 Sodium Hypochlorite: Sodium hypochlorite is supplied in strengths from five and one-quarter (5.25%) to sixteen (16%) percent available chlorine. It is packaged in liquid form in glass, rubber, or plastic containers ranging in size from one (1) quart bottles to five (5) gallon carboys. It may also be purchased in bulk for delivery by tank truck.

The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.

2.4.2.3 *Application*: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All

connections shall be checked for tightness before the hypochlorite solution is applied to the main.

2.5 METHODS OF CHLORINE APPLICATION

2.5.1 Continuous Feed Method: This method is suitable for general application.

2.5.1.1 Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate into the newly-laid pipe line. The water shall receive a dose of chlorine, also fed at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 mg/L available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the procedures described in the current edition of Standard Methods and AWWA M12—Simplified Procedures for Water Examination.

NOTE: In the absence of a meter, the rate may be determined either by placing a pitot gauge at the discharge or by measuring the time to fill a container of known volume. TABLE K-3 gives the amount of chlorine residual required for each one hundred (100) feet of pipe of various diameters. Solutions of one (1%) percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately one pound (1 lb.) of calcium hypochlorite in eight and five tenths (8.5) gallons of water.

Table K-3
Chlorine Required To Produce 50 mg/L Concentration
In 100 Ft. Of Pipe (By Diameter)

Pipe Size (in)	100 Percent Chlorine (lb)	1 Percent Chlorine Solutions (gal)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88

2.5.1.2 During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least twenty-four (24) hours during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this twenty-four (24) hour period, the treated water shall contain no less than 25 mg/L chlorine throughout the length of the main.

2.5.2 Slug Method: This method is suitable for use with mains of large diameter for which, because of the volumes of water involved, the continuous feed method is not practical.

2.5.2.1 Water from the existing distribution system or other approved source of supply shall be made to flow at a constant, measured rate (see section 2.5.1.1) into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant, measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg/L. The chlorine shall be applied continuously and for a sufficient period to develop a solid column or "slug" of chlorinated water that will, as it passes along the line, expose all interior surfaces to a concentration of at least 300 mg/L for at least three (3) hours. The application shall be checked at a tap near the upstream end of the line by chlorine residual measurements.

2.5.2.2 As the chlorinated water flows past tees and crosses, related valves and hydrants shall be operated as to disinfect appurtenances.

2.6 FINAL FLUSHING

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipe line.

2.7 BACTERIOLOGIC TESTS

2.7.1 After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least one sample shall be collected from chlorinated supplies where a chlorine residual is maintained throughout the new main. From un-chlorinated supplies at least two samples shall be collected at least twenty-four (24) hours apart.

2.7.2 Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed, and retained for future use.

2.8 REPETITION OF PROCEDURE

If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained. The tablet method cannot be

used in these subsequent disinfections. When the sample tests indicate that disinfection has been effective, the main may be placed in service.

2.9 PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING MAINS

The procedures outlined in this Section apply primarily when mains are wholly or partially dewatered. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure present little danger of contamination and require no disinfection.

2.9.1 Trench "Treatment": When an old line is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.

2.9.2 Main Disinfection: The following procedure is considered as a minimum that may be used.

2.9.2.1 *Swabbing with Hypochlorite Solution*: The interior of all pipe and fittings used in making the repair (particularly couplings and tapping sleeves) shall be swabbed with a five (5%) percent hypochlorite solution before they are installed.

2.9.2.2 *Flushing*: Thorough flushing is the most practical means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions is recommended. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.

2.9.2.3 *Slug Method*: Where practicable, in addition to the procedures of section 2.9.2.1, a section of main in which the break is located shall be isolated, all service connections shut off, and the section flushed and chlorinated as described in section 2.5.2, except that the dose may be increased to as much as 500 mg/L, and the contact time reduced to as little as one-half (1/2) hour. After chlorination, flushing shall be resumed and continued until discolored water is eliminated.

2.9.3 Sampling: Bacteriologic samples shall be taken after repairs to provide a record by which the effectiveness of the procedures used can be determined. If the direction of flow is unknown, samples shall be taken on each side of the main break.

3.0 PAYMENT

No separate payment shall be made for testing and sterilization. Items described in this section shall be incidental to the cost of the project.

END OF SECTION

SECTION 13200

BULK CHEMICAL STORAGE TANKS

PART 1 – GENERAL

1.1 This specification covers upright, cylindrical, flat bottom tanks molded in one-piece seamless construction by rotational molding. The tanks are designed for above-ground, vertical installation and are capable of containing chemicals at atmospheric pressure. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship, and appearance.

1.2 This specification does not cover the design of vessels intended for use at pressures above or below atmospheric conditions. It is also not for vessels intended for use with liquids heated above their flash points, temperatures above 140 degrees Fahrenheit for Type I materials, or temperatures above 130 degrees Fahrenheit for Type II materials (see below for material classifications).

1.3 Bulk storage tanks and all necessary appurtenances shall conform to the applicable ASTM (American Society for Testing and Materials) Standards:
D618 Conditioning Plastics and Electrical Insulating Materials for Testing
D638 Tensile Properties of Plastics
D790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D883 Definitions of Terms Relating to Plastics
D1505 Density of Plastics by the Density-Gradient Technique
D1525 Test Method for Vicat Softening Temperature of Plastics
D1693 Test Method for Environmental Stress-Cracking of Ethylene Plastics
D1998 Standard Specification for Polyethylene Upright Storage Tanks
D2765 Degree of Crosslinking in Crosslinked Ethylene Plastics as Determined by Solvent Extraction
D2837 Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
D3892 Practice for Packaging/Packing of Plastics
F412 Definitions of Terms Relating to Plastic Piping Systems

1.4 ARM (Association of Rotational Molders) Standards: Low Temperature Impact Resistance (Falling Dart Test Procedure)

1.5 ANSI Standards: B-16.5 Pipe Flanges and Flanged Fittings

1.6 OSHA Standards: 29 CFR 1910.106 Occupational Safety and Health Administration, Flammable and Combustible Liquids

1.7 UBC CODE: Uniform Building Code 1997 Edition

PART 2 – PRODUCTS

2.1 MATERIALS

Tanks are classified according to type as follows and it is the responsibility of the purchaser to specify Type I or Type II.

Type I - Tanks molded from cross-linkable polyethylene resin.
Type II - Tanks molded from linear polyethylene resin.

2.1.1 The material used shall be virgin polyethylene resin as compounded and certified by the manufacturer. Type I tanks shall be made from crosslinked polyethylene resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties. Type II tanks shall be made from linear polyethylene resin as manufactured by ExxonMobil Chemical, or resin of equal physical and chemical properties.

2.1.2 All polyethylene resin material shall contain a minimum of a U.V. 8 stabilizer as compounded by the resin manufacturer. Pigments may be added at the purchaser's request, but shall not exceed 0.25% (dry blended) of the total weight.

Mechanical Properties of Type I tank material:

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.938-0.946 g/cc
Tensile (Yield Stress 2"/min)	D638	3000 PSI
Elongation at Break (2"/min.)	D638	>300%
ESCR (100% Igepal, Cond. A, F50)	D1693	>1000 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	>1000 hours
Vicat Softening Degrees F. Temperature	D1525	250
Flexural Modulus	D790	100,000 PSI

Mechanical Properties of Type II tank material:

PROPERTY	ASTM	VALUE
Density (Resin)	D1505	0.940-0.948 g/cc
Tensile (Yield Stress 2"/min)	D638	2950 PSI
Elongation at Break (2"/min.)	D638	>1000%
ESCR (100% Igepal, Cond. A, F50)	D1693	550 hours
ESCR (10% Igepal, Cond. A, F50)	D1693	48 hours
Vicat Softening Degrees F. Temperature	D1525	235
Flexural Modulus	D790	129,000 PSI

2.1.3 The minimum required wall thickness of the cylindrical shell at any fluid level shall be determined by the following equation, but shall not be less than 0.187 in. thick:

T= P x O.D. / 2 SD
T= wall thickness
SD= hydrostatic design stress, PSI
P= pressure (.433 x S.G. x H), PSI
H= fluid head, ft.
S.G.= specific gravity, g/cm^3
O.D.= outside diameter, in.

2.1.4 The hydrostatic design stress shall be determined by multiplying the hydrostatic design basis, determined by ASTM D2837 using rotationally molded samples, with a service factor selected for the application. The hydrostatic design stress is 600 PSI at 73 degrees Fahrenheit for Type I and Type II materials.

2.1.5 The hydrostatic design stress shall be derated for service above 100 degrees Fahrenheit and for mechanical loading of the tank.

2.1.6 The standard design specific gravity for materials to be stored shall be greater than or equal to 1.9. The minimum required wall thickness for the cylinder straight shell must be sufficient to support its own weight in an upright position without any external support. Flat areas shall be provided to allow locating large fittings on the cylinder straight shell. The top head must be integrally molded with the cylinder shell. The minimum thickness of the top head shall be equal to the top of the straight wall. The top head of tanks with 2000 or more gallons of capacity shall be designed to provide a minimum of 1300 square inches of flat area for fitting locations.

2.1.7 Tanks with 2,000 or more gallons of capacity shall have a minimum of 3 lifting lugs integrally molded into the top head. The lifting lugs shall be designed to allow erection of an empty tank.

2.1.8 The tank shall be designed to provide a minimum of 4 tie-down lugs integrally molded into the top head. The tie-down lugs shall be designed to allow tank retention in wind and seismic loading situations without tank damage.

2.1.9 Tank manufacturer shall verify the chemical compatibility of the tanks construction materials with the chemical being stored.

2.2 DIMENSIONS AND TOLERANCES

2.2.1 All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

2.2.2 The tolerance for the outside diameter, including out of roundness, shall be per ASTM D1998.

2.2.3 The tolerance for fitting placements shall be +/- 0.5 in. in elevation and 2 degrees radial at ambient temperature.

2.3 WORKMANSHIP

2.3.1 The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel. Fine bubbles are acceptable with Type II tanks to the degree in which they do not interfere with proper fusion of the resin melt.

2.3.2 All cut edges where openings are cut into the tanks shall be trimmed smooth.

2.4 TANK FITTINGS (NOZZLES)

2.4.1 Threaded bulkhead fittings shall be provided for below liquid installation depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. The maximum allowable size for bulkhead fittings placed on a curved sidewall section of tanks 48 in. to 142 in. in diameter is 2 inch size. Tank wall thickness must be considered for bulkhead fitting placement. The maximum wall thickness for each fitting size is shown below.

Fitting Size	**Maximum Wall Thickness**
1/2 in.	0.750 in.
3/4 in.	0.875 in.
1 in.	0.875 in.
1 1/4 in.	0.875 in.
1 1/2 in.	0.875 in.
2 in.	1 in.
3 in.	1.125 in. (Flat Surface Only)

2.4.2 The bulkhead fittings shall be constructed of PVC, PP, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton®, or other specified material.

2.4.3 Bolted double flange fittings are required for below liquid level installation for sizes above 2 in. depending on the tank diameter and the placement of the fitting in the tank. Fittings must be placed away from tank knuckle radius' and flange lines. Bolted double flange fittings provide the best strength and sealing characteristics of any tank fitting available. Allowable fittings sizes based on tank diameter for curved surfaces are shown on the following page.

Tank Diameter	Maximum Bolted Fitting Size Allowable
48 in. - 86 in.	3 in.
90 in. - 102 in.	6 in.
120 in. - 142 in.	8 in.

The bolted double flange fittings shall allow tank wall thickness up to 2 1/2 in.

2.4.4 The bolted double flange fitting shall be constructed with 2 ea. 150 lb. flanges, 2 ea. 150 lb. flange gaskets, and the correct number and size of threaded bolts for the flange specified by the flange manufacturer. The flanges shall be constructed of PVC Type I, Grade I, or other specified material. Gaskets shall be a minimum of 1/4" thickness and constructed of 40-50 durometer EPDM, 60-70 durometer Viton® or other specified material. There shall be a minimum of 4 ea. full thread bolts. The bolts may have gasketed flanged metal heads or bolt heads encapsulated in Type II polyethylene material. The encapsulated bolt shall be designed to prevent metal exposure to the liquid in the tank and prevent bolt rotation during installation. The polyethylene encapsulation shall fully cover the bolt head and a minimum of 1/4" of the threads closest to the bolt head. The polyethylene shall be color coded to distinguish bolt material (white - 316 S.S., yellow - Hastelloy C276, red - Monel, green - Titanium). Each encapsulated bolt shall have a gasket to provide a sealing surface against the inner flange.

2.4.5 Standard orientation of bolted double flange fittings shall have bolt holes straddling the principal centerline of the tank in accordance with ANSI/ASME B-16.5 unless otherwise specified.

2.5 INTEGRALLY MOLDED OUTLET

2.5.1 The outlet fitting shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom container without the use of a special support structure or concrete pad. The standard outlet to be provided shall be a PVC socket which allows solvent weld PVC pipe attachments at the tank pad level.

2.6 TANK ATTACHMENTS

2.6.1 Sight Level Gage

The sight level gage shall be constructed of clear, flexible, polyethylene tubing to allow for tank contraction and expansion due to loading and temperature changes. The level gage shall be connected to the tank via two (2) 3/4" fittings and 3/4” isolating ball valves as described in this specification.

2.6.2 Bolted Sealed Top Manway

The sealed manway shall be constructed of polyethylene material. The bolts shall be polypropylene or other specified material. The gaskets shall be closed cell, crosslinked polyethylene foam and Viton® materials.

2.6.3 Tie Down Systems

Tank manufacturer shall provide tank with an integral tie down system. Tie down system shall be designed to withstand 110 MPH wind loads and system must meet seismic zone 4 requirements per UBC code. Tank shall be tethered using the integral tie down system to concrete block wall using anchor bolts that are to be provided by the contractor. Contractor shall install the tether system per the manufacturer's instructions.

The tie down system shall be 316 stainless steel, or other materials as specified by engineer.

All steel parts shall be deburred, prepped with etching primer, and painted with a chemical resistant enamel paint.

2.7 BULK STORAGE TANK SCHEDULE

Tank Description	Hydrofluosilicic Acid, 25% (TK-1)	Hydrofluosilicic Acid, 25% (TK-2)
Capacity (gallons)	500	500
Diameter	3' – 0''	3' – 0''
Wall Cylinder Height	10' – 0''	10' – 0''
Outlet	1" – 90°	1" – 90°
Fill (Top)	2" - 315°	2" - 315°
Vent	2" - 45°	2" - 45°
Overflow	2" - 90°	2" - 270°
Top Manway	18" - Center	18" - Center
Level Gauge		3/4" - 120°

Note: The radial dimensions given in the Tank Schedule correspond to a clock face as:

0°- 12 o'clock (wall side of tank), 90° - 3 o'clock, 180° - 6 o'clock (viewing side of tank), 270° - 9 o'clock.

PART 3 – EXECUTION

The tanks shall be marked to identify the product, date (month and year) of manufacture, capacity, and serial number. The tank shall be shipped with a 3 of 9, HRI bar code label containing tank description, manufacturing order number, part number, serial number, manufacturer, and date.

The proper caution or warning signs as prescribed by OSHA standard 29 CFR 1910.106 shall be customer determined and supplied. All packing, packaging, and marking provisions of ASTM Practice D3892 shall apply to this specification.

All fittings that do not interfere with tank shipment shall be installed unless otherwise specified. Fittings and accessories that interfere with tank shipment or could be broken during shipment shall be shipped separately.

Upon arrival at the destination, the purchaser and/or his agent shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser, and the manufacturer should be notified prior to the tank being put into service.

END OF SECTION

SECTION 13220

FILTER EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work Included. All of the equipment described in this section shall be supplied by a single underdrain manufacturer regularly engaged in that business. This section requires the furnishing and installation of filters and equipment as shown on the contract drawings. Each filter is 10'-0" x 18'-0" x 11'-0" deep. The equipment to be supplied shall consist of:

1. Filter underdrain with integral media support cap (IMS®)
2. Filter media
3. Surface Agitators
4. Fiberglass filter troughs and support system

B. References:

1. NSF - Standard 61 - Drinking Water Systems Components - Health Effects.

2. AWWA B100 Water Treatment Filtering Material latest edition.

3. ANSI/AWWA F101 Contact-Molded, Fiberglass-Reinforced Plastic Wash water Troughs and Launders.

4. ASTM Standards listed in Section 1.4.F, Table 1.

1.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Requirements

1. The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.

2. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water and over the total area of the filter floor.

3. The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other

deleterious disturbances in the filter media.

4. When subjected to a flow rate of 20 gallons per minute per square foot (gpm/sf) of filter area, the headloss through an underdrain lateral 16 feet (4.8 m) long shall not exceed 36 inches (910 mm) water column when the water temperature is approximately 60° F (16° C). This does not include head losses for special feed arrangements.

5. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches (510 mm) water column at a backwash flow rate of 20 gpm/sf (48.9 m/h) of filter area when the water temperature is approximately 60°F (16° C).

6. The filters shall consist of 12 inches of silica sand media, and 18 inches of anthracite media.

7. The wash water troughs shall be as described in the contract plans and specifications. Each trough carry off capacity shall be 1,800 gpm with a freeboard of at least 2 inches. Adjustable straight edge weir plates, if required, shall be of fiberglass reinforced polyester laminate made by the matched die method.

B. Design Flow Rates: The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:

1. Downflow of filtered water up to 10 gpm/sf

2. Upflow of backwash water up to 20 gpm/sf.

C. Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:

1. Lateral Water MD: The maldistribution in a lateral 16 feet (4.8 m) long or less shall not exceed +/- 2 percent of the average gpm/sf of filter for a backwash rate of 20 gpm/sf.

2. Flume Water MD: Note, additional maldistribution, due to specific flume arrangement, entry conditions into both flume and underdrain laterals and flow velocities, must be considered.

D. Structural Design Requirements

1. General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loadings for the specified conditions.
2. Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of 600 psf or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.

3. Downward Load: The filter underdrain system shall also be designed to withstand a net downward loading of not less than 1,400 psf.

1.3 QUALITY ASSURANCE

A. Manufacturer: The filter system shall be supplied by one manufacturer that shall assume total responsibility for the parts operating as a whole.

B. Experience: The filter system shall be a standard product of a filter manufacturer who has been actively providing underdrain equipment for at least 15 years. Upon request, the filter manufacturer will provide the ENGINEER with a list of installations of underdrain which totals not less than 100.

C. NSF Certification: All materials to be used that will be in contact with the water shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.

D. Underdrain: The dual-parallel block units and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.

E. Media: The filter equipment manufacturer shall furnish a Quality Control Manual demonstrating that the filter media to be furnished will comply with the requirements of the contract specifications. The Quality Control Manual will define the following:

1. Qualification of the raw feedstock
2. Control procedures at the screening mill
3. Independent testing laboratories
4. Packaging definition
5. Purchase orders
6. Storage procedures

1.4 SUBMITTALS

A. Submit to the engineer complete shop drawings showing details of fabrication, materials of construction, installation and leveling data of all items furnished under this section.

B. Details submitted shall include as a minimum, headloss data, structural design calculations, installation details, flow distribution calculations, certification of compatibility of the underdrain system with the filter media specified in this section, details for installing reinforcing and other items to be embedded in concrete.

C. Testing Procedures: Detailed start-up, and hydraulic test procedures.

D. Proper documentation showing NSF-61 certification of all underdrain components.

E. The media submittal and technical information will be provided and approved by a licensed engineer regularly employed by the filter manufacturer. The engineer shall have at least 15 years experience in water treatment. All submittal shall include the following information as a minimum:

1. Supplier's Name
2. Resume of Engineer Providing Submittal
3. Quality Control Manual
4. Gradation of Each Media Type
5. Date of Sampling/Lot Number
6. Samples of Each Media Type (If Required)
7. Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and MOH hardness)
8. Material Quantities
9. Diagram with Type of Material and Depth of Each
10. Estimated Shipping Schedule
11. Media Loading Procedure
12. All testing shall conform to the requirements of the latest edition of AWWA B100.

F. Wash Water Trough Testing

1. Manufacturer shall, upon request, furnish the Engineer with certified test reports consisting of the mechanical and physical tests listed below.

2. Procedure to be used in determining the properties listed in Table 1 below shall be in accordance with latest ASTM standards: Ultimate Tensile Strength - ASTM Designation D638; Flexural Strength - ASTM Designation D790; Modulus of Elasticity - ASTM Designation D790; Hardness - ASTM Designation D2583; Water Absorption - ASTM Destination D570.

3. Hardness tests shall be made on the resin-rich surface of the product.

4. Flexural tests shall be made with resin-rich surface in compression.

5. Test samples shall be full thickness of the item produced and shall not be

machined on the surface.

6. Mechanical and physical properties shall conform to those of Table 1 and according to ANSI-AWWA specification F101 Table 4 - Minimum Physical Properties of Laminates.

Table 1 Laminate Mechanical and Physical Properties 73°F		
Property	ASTM Test Method	1/4" Wall Thickness
Ultimate Tensile Strength	D638	12,000 psi min.
Flexural Strength	D790	19,000 psi min.
Flexural Modulus of Elasticity	D790	900,000 psi min.
Barcol Hardness	D2583	35 min.
Water Absorption	D570	0.20% max.

1.5 SHIPMENTS

A. Media materials will not be shipped until the submittal is approved by the Owner. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media.

B. The Contractor shall be responsible for coordinating the shipment of supplies of materials and equipment specified herein. Coordination will be required during demolition, construction, start-up, and/or testing.

C. The Contractor shall provide storage space for filter media and protect it from exposure to sunlight if stored for more than two weeks. Paper bags (if used) shall be protected from moisture at all times.

PART 2- PRODUCTS

2.1 DESCRIPTION

A. Underdrain

1. The underdrain system for the filters shall be a dual parallel lateral type with an integral media support cap whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures will not be considered acceptable. The primary chamber should provide at least 30 square inches of cross sectional area per block to

reduce flow velocity during backwash.

2. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 7/32 inches diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch. The top of each orifice shall be encircled by a depression approximately 3/8 inch x 3/4 inch, which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.

3. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.

B. Surface Agitator

1. The design shall consist of a ball bearing type central housing stabilized for vertical and horizontal bearing pressure, containing a stainless steel ball bearing assembly which is packed in grease and sealed from the water passage by means of a non-adjustable, self-compensating, and Buna-N quad-ring seal.

2. Suspended from the center bearing housing shall be a tee having a nozzle affixed so as to emit a jet at the center of the tee at a 15-degree angle from the horizontal. The tee shall contain two (2) rotating lateral arms which are permanently fitted to the tee to prevent movement or rotation of the lateral arms in relation to the tee. Lateral arms shall consist of pipe graduated for best hydraulic delivery to distributing nozzles attached to said lateral arms. Lateral arms shall be designed of the proper pipe sections to suit standard design in relation to overall length and required strength of the unit.

3. The rotating lateral arms shall consist of a straight section of pipe, graduated when necessary, extending horizontally from the central tee.

4. Nozzles shall be attached to the trailing edge of the central straight portion of the lateral arms, the forward leading edge of middle section, and the trailing end section in such a manner as to impart four (4) distinct agitating actions to each corner and void area of the filter during one complete revolution.

5. Nozzles on the lateral arms shall be set at 15-degree downward angle form the horizontal plane optimum cleaning of the filter media. Nozzles shall be threaded into the lateral arms to facilitate easy replacement.

6. Each surface wash agitator shall be designed to deliver 61 gpm at an operating pressure of 50 psi.

C. Filter Media

1. Filter sand shall be composed of hard, durable clean siliceous particles, free of all mica with an average specific gravity of 2.6 (+/-.05) and shall be in strict accordance with AWWA B100, and have an effective size of .45-.55 mm, and a uniformity coefficient of 1.40 or less, for a finished depth after backwashing and scraping and removal of fines and debris of 12 inches. For depths up to 12 inches (305 mm), a 1-inch skimming allowance shall be provided.

2. Filter anthracite shall be composed of specially selected and graded hard, durable anthracite coal particles. The anthracite shall be composed entirely of deep mined material. A quality control manual shall be included to show the source of the material and the quality of the material produced. The anthracite shall have an average specific gravity of 1.65 (+/-0.05) with a hardness (MOH scale) of 2.7 or more and shall be essentially free of iron, clay, shale, extraneous dirt, and excessive dust with moisture less than 4.0 percent as shipped. The anthracite shall be in accordance with AWWA B100, and have an effective size of .95-1.05 mm, and a uniformity coefficient of 1.40 or less for a finished depth after backwashing and scraping and removal of fines and debris of 18 inches. A skimming allowance of 1-1/2 inches shall be provided.

D. Fiberglass Wash Water Troughs

1. Loadings - The troughs shall be designed to support, within stress and deflection limitation, the following loadings:

a. Gravity Load - Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.

b. Buoyant Load - The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.

c. Lateral Load - Loads acting against the trough side walls; specifically, those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and when the tank is empty, shall be used when calculating deflection, fiber stress, etc.

2. Thermal Stresses - The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal

expansion (contraction) between the trough and tank/support materials.

3. Torsional Stability - The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered.

a. Trough-to-trough stabilization
b. Torsional stiffness
c. Support spacing and rigidity
d. Internal baffles and/or flow straighteners

4. Deflection Under Load - Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to L/1000, where L is defined as the unsupported trough length in inches. Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inch.

a. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

b. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the trough width, in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

5. Fiber Stress Limitations - Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1500 psi. This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.

6. Thermal Expansion/Contraction - The troughs shall be designed to accommodate a thermally induced expansion (contraction) of 1/8 inch per 20 foot length of trough over temperature range of 10 degrees F to 100 degrees F, without exceeding the deflection or strain limitations set forth in the preceding sections.

2.2 MATERIALS AND CONSTRUCTION

A. Underdrain

1. Material: The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have

uniform smooth surfaces.

2. Dimensions: The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 12 inches high by 11 inches wide by 48 inches long. The weight of the block shall be approximately 23 pounds.

3. Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout.

4. Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be sealed utilizing only one (1) O-Ring seal, bell and spigot type with internal alignment tabs for proper joint alignment, and be water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation of the laterals. One-piece extruded underdrain will not be considered acceptable.

5. Media Support Cap: The cap shall be constructed of HDPE plastic beads sintered together and sealed to the top of the underdrain. The pore size and pore volume shall be sufficient to prevent the media from obstructing or passing through the underdrain. The cap shall replace the need for support gravel and shall not increase the underdrain height by more than 1 inch. The cap shall be attached to the underdrain at the factory by type 316 stainless steel self tapping screws and sealed with caulking.

B. Grout Retainer

1. Grout retaining strips for bridging flumes shall be of high-impact polystyrene properly keyed to fit the underdrain blocks to allow adjustment of lateral center-to-center distance without difficulty. Retaining strips shall be supplied by the filter manufacturer.

C. Grout

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become “lumpy” shall not be used. Do not use non-shrink grout.

2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Agriculture water with a total dissolved solids of 1000 mg/l or higher, shall not be used.

3. Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.

4. Chemical Admixtures: No chemical admixture is needed in most of the applications. The grout can be mixed in a small batch and used immediately.
5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3000 psi after 30 days of curing.

D. Surface Agitator

1. Each agitator unit shall essentially consist of a drop pipe terminating in a rotary joint bearing assembly that is connected at its lower end to an arm assembly.

2. The rotary bearing assembly shall consist of a Type 304 stainless steel body with packed stainless steel bearings and protected by Quad Ring Seals. The rotary bearing assembly shall be easily disassembled. The use of a non metallic body for the bearing assembly shall not be allowed.

3. The agitator arm unit shall consist of a single, continuous horizontal arm fabricated of a single section of Schedule 5 Type 304 stainless steel. The bottom of the rotary joint bearing assembly shall be unitized to the horizontal arm. Units with arm assemblies of more than one piece or units requiring field assembly using tee type assemblies shall not be allowed. Units fabricated with screwed, press fit, pinned, or soldered arms shall not be allowed.

4. The distributor arm shall be provided with threaded, non clogging nozzles, so spaced that the water distribution shall be substantially uniform over the entire area of influence of the rotary media agitator. Nozzles shall be arranged in such a manner as to impart rotation of the distributor arm when water pressure is applied and shall be threaded into tapped orifices along the distributor arm. Nozzles shall be directed at a 15 degree angle downward from the horizontal plane. Compression or drive fit attachment of nozzles to the distributor arm shall not be allowed.

5. Nozzles shall have a stainless steel directional throat being at ¼'' at base and 9/10'' diameter at discharge. The stainless steel throat will be capable of maintaining a concentrated spray pattern. Unprotected plastic or rubber caps will not be allowed. The back flow media preventer shall be retained. Unrestrained preventers shall not be allowed. Each distributor arm shall be fitted

with an endcap assembly containing three (3) integral discharge nozzle openings. Endcaps which are removable for flushing shall not be allowed.

6. A distance of 2 ½'' shall be provided between the top of the filter media and the centerline of the agitator distributor arm. Surface wash agitators shall be NSF 61 Listed.

7. All supply piping within the filter unit shall be Schedule 5 Type 316L stainless steel. The pipe sections shall be factory cut and welded to the required dimensions for field assembly. No welding shall be permitted on the jobsite. Whenever pipe must be field connected, rolled grooves shall be provided and the sections joined together with coated Victaulic type couplings.

8. Type 316 stainless steel agitator supply header support brackets and securement hardware shall be furnished for adequate support of the supply piping from the wash water troughs and from the filter walls. All structural members shall be 3/16'' minimum thickness and "U" bolts for the pipe securement to support brackets shall be 3/8'' minimum diameter.

9. Drop pipes to the individual agitator mechanisms from the main supply piping shall be 2'' diameter, Schedule 40 Type 316 stainless steel.

E. Wash Water Troughs:

1. Resin: The resin shall be a commercial grade, general purpose polyester thermosetting resin, which has either been evaluated in a laminate, or which has been determined by a previous documented service to be acceptable for the service conditions. Contact the factory for specific chemical resistant applications.

a. The resin shall contain no fillers except as follows:

1) A thixotropic agent which does not interfere with laminate quality, or with the required chemical resistance of the laminate, may be added for viscosity control.

2) Resin may contain pigments, dyes or colorants which have been determined by at least five (5) years previous service to be acceptable for the service condition without fading or chalking from original color standard.

2. Ultraviolet Resistance: All laminates have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.

3. Metal Reinforcement: When metal reinforcements are used, they shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated

with a minimum of 1/8 inch thick laminate.

4. Glass Reinforcement: Glass reinforcements shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be type C, 10-20 mils thick, with a silane finish and a styrene-soluble binder. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder. The glass content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Table 1.

5. Supports and Bracing: All supports and bracing shall be constructed from type 316L stainless steel or 6061 aluminum. The anchors and hardware for anchoring shall be type 18-8 stainless steel.

6. Manufacture:

a. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.

b. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (max. 2 oz. per sq. ft.) in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2-1/2% of laminate volume.

c. The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8 inch (measured when the trough is not loaded).

1) The length of a trough section shall have a tolerance of +/-1/8 inch per 10 feet length.

2) The laminate thickness tolerance shall be plus 1/8 inch.

d. Thickness at locations of supports such as saddles shall be at least 1-1/2 times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of the specification.

e. End flanges and blind ends shall be a minimum of 1 1/2 times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this specification.

f. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.

g. One-inch diameter ABS spreaders shall be bolted between the trough walls on approximate 2 feet centers to enhance the structural rigidity of the

trough system.

PART 3 – EXECUTION

3.1 PRODUCT HANDLING, STORAGE AND DELIVERY

A. Place or store underdrains and specialties only in designated staging areas shown on the drawings and approved by the Engineer.

B. Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the filters.

C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.

D. Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

E. All filter media will be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout. Anthracite superbags are 60 cubic feet weighing approximately 3,000 pounds each

F. Delivery of "bulk" shipments will not be permitted unless the contractor can demonstrate that the materials can be handled and stored without contamination

G. Equipment shall be suitably packaged to avoid damage during handling and shipment. Should it be necessary to store product prior to installation, precautions should be taken to prevent warpage or distortion.

H. Troughs should be stored on a flat place and adequately supported on wooden support members to evenly distribute weight of troughs. When stored more than one (1) high, succeeding items should be stored level and evenly supported by blocks or spacers.

3.2 INSTALLATION

A. Filter Underdrains

1. The CONTRACTOR shall install the filter underdrain system in strict accordance with: (1) the manufacturer's written instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the WORK; and (3) any additional requirements specified herein.

2. Floor Preparation

a. Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions.

b. DO NOT PAINT the floor or wall area where it will come in contact with the grout surrounding the underdrain. The filter floor and filter wall extending thirteen (13) inches up from the filter floor is not to be painted.

3. Underdrain Lateral Installation

a. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the CONTRACTOR. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least 7 full days before any functional testing.

4. Cleaning and Protection During Installation, Testing, and Startup

a. The CONTRACTOR shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith 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 cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the WORK shall be protected with heavy visqueen or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the media is installed.

b. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½ inch minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

B. Media

1. Marks shall be placed on the side of the filter designating the top elevation of each layer.

2. Carefully place each layer so as not to disturb the previous layers.

3. Complete the installation of each layer before the next layer above is started. Do not stand or walk directly upon the filter materials. Workers must stand or walk on boards that will sustain their weight without displacing the gravel and media.

4. Measure depth of each layer of media after it has been backwashed and skimmed as recommended by the filter equipment manufacturer.

5. Clean the filter tanks before any media is placed and keep them clean throughout the placing operation.

6. Filter Sand and Filter Anthracite: Place the filter sand and filter anthracite in the bed in the order of their respective specific gravities. Place and level the filter sand first. Then backwash the bed a minimum of three times, and remove the surface fines after each backwash cycle by scraping as required to arrive at the correct finished elevation. Place the filter anthracite and backwash the bed three times, and remove the surface fines after each backwash cycle by scraping as required to arrive at the correct finished elevation.

C. Surface Agitator

1. The surface wash system shall be installed as per the written instructions of the Manufacturer.

2. The surface wash supply shall provide a minimum of 50 psi for the proper operation of the agitators.

3. All surface wash agitators shall be installed level and plumb. All necessary precautions recommended by the Manufacturer shall be followed to ensure that the distribution system and surface wash supply piping is completely clean and free of any debris, dirt or other foreign materials which could clog the system or interfere with flow.

D. Wash Water Troughs

1. All trough mounting brackets, hardware and stabilizers shall be Type 18-8 stainless steel and shall be supplied by the trough manufacturer.

2. Troughs shall be installed so that the trough weir edges are level to within ± 1/8 inch.

3.3 FIELD TESTING

A. Underdrain Lateral Flow Distribution Test

1. The filter underdrain system in each filter cell shall be given a series of visual, qualitative, flow distribution tests to verify that orifices are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.

2. During each test, the underdrain laterals shall be visually inspected for uniform distribution of air and water and for any signs of quiescent zones and excessive surface turbulence.

3.4 MANUFACTURER'S SERVICES

A. Mechanical Filter Equipment Services

1. Install all items in accordance with the filter equipment manufacturer's recommendations. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filtering materials have been installed in accordance with the manufacturer's instructions.
2. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of underdrain. (Such persons shall be available on a fee-paid basis to instruct the CONTRACTOR in the proper placement and testing of the underdrain).

3. The CONTRACTOR shall provide the services of the manufacturer's technical representative for the installation and testing of the filter underdrain system.

B. Surface Agitator

1. The surface wash equipment Manufacturer shall maintain a qualified staff of factory trained field service personnel. Their staff shall include regular, full time employees of the Manufacturer with suitable training and experience with installation and operation of the type of equipment being supplied.

2. Supervisory services of a factory trained field service Engineer shall be provided for a period of 2 days on-site to check equipment setting and supervise the installation of the system.

3. The services of such designated manufacturer representative shall be included in the contract price. The service times specified above shall be considered as full eight (8) hour working days and do not include travel time.

3.5 DISINFECTION

A. After all work is completed and before the filter is placed in service, the Contractor will disinfect the entire filter by chlorination.

3.6 SPARES

A. Spares shall be provided as follows:
1. Ten (10) underdrain O-rings
2. Five (5) H.I.P.S bridging pieces
3. Five (5) Plastic end caps
4. Five (5) Agitator Nozzles

END OF SECTION

SECTION 13400

ONLINE TURBIDITY ANALYZING EQUIPMENT

PART 1 GENERAL

1.1 Section includes:

A. Instrument for continuous, online monitoring of turbidity in water that includes predictive diagnostics capability to monitor instrument status using one of the following compliance methods:

U.S. EPA Approved Hach Method 10258

1.2 Measurement Procedures

A. The sensor is used with an SC controller to measure low range turbidity in water. These sensors collect scattered light at an angle of 90° in a 360° radius around the axis of the incident light beam.

1.3 Alternates

A. Any proposed equipment meeting the below listed specifications shall be considered equal. Equipment that uses methods of turbidity measurements that do not include a laser light source and a 360° x 90° detection system are not acceptable.

1.4 System Description

A. Performance Requirements

U.S. EPA Approved Hach Method 10258 Sensor

a. Measuring Range
   1) 0 to 700 Nephelometric Turbidity Units (NTU)

B. Other Specifications

a. Detection Limit
   1) 0.002 NTU
b. Accuracy
   1) ±2% of reading ±0.01 NTU from 0 to 40 NTU based on formazin primary standard at 25°C
   2) ±10% of reading from 40 to 1000 NTU based on formazin primary standard at 25°C
c. Repeatability
   1) ±1% of reading or 0.002 NTU, whichever is greater based on formazin primary standard at 25°C
d. Resolution
   1) 0.0001 NTU
e. Response Time
   1) T90 <30s at 100 mL/min
f. Sample Flow
   1) 100 to 1000 mL/min; optimal flow rate 200 to 500mL/min

g. Sample Pressure
    1) Max. 87 psi compared to air at sample temperature range of 32 to 104 °F
    2) Max. 43 psi compared to air at temperature range of 104 to 140 °F
h. Sample Temperature
    1) 36 to 140 °F

1.5 Certifications
A. CE Compliant
B. US FDA accession number: 1420493-001 EPA version. Complies with IEC/EN 60825-1 and to 21 CFR 1040.10 in accordance with Laser Notice No. 50
C. Australian RCM Marking

1.6 Environmental Requirements
A. Operational Criteria
    1. Storage Temperature: -40 to 140 °F
    2. Operating Temperature: 32 to 122 °F
    3. Relative Humidity: 5 to 95 %, non-condensing

1.7 Maintenance Service
A. Unscheduled Maintenance
    1. Clean the measurement vial, depending on cleanliness of the sample
    2. Replacement of desiccant cartridge (depending on ambient temperature, ambient humidity, and sample temperature)
    3. Replacement of measurement vial, depending on cleanliness of the sample

PART 2 PRODUCTS

2.1 Manufacturer
A. Hach TU5300sc Online Low Range Laser Turbidimeter
B. Approved Equal

2.2 Sensor
A. The low range online laser turbidimeter consists of a Class 1 650nm (EPA) laser light source and 360° x 90° detection system designed to continuously monitor turbidity in a sample stream.

2.3 Equipment
A. Online turbidimeter
    1. Utilizes a laser-based 360° x 90° optical system that measures turbidity from multiple different angles.
    2. Continuous particle removal using a vortex created by the fluid path.

3. Utilizes an identical laser-based optical system that matches the laboratory turbidimeter described in 2.3.C. for direct comparison between laboratory and online measurements.
4. Includes capability to actively monitor all internal components and present diagnostics on the overall health of the turbidimeter and time to next required maintenance.
5. When connected to a predictive diagnostics capable controller, the overall status of instrument performance is displayed as a percentage value via a measurement indicator
6. When connected to a predictive diagnostics capable controller, the overall time remaining until maintenance tasks are due is displayed in days
7. Built in-help screens included.

B. Controller
1. Provide an SC controller for Turbidimeter operation. Include the capability to communicate measurements and calibration information via LAN to the laboratory Turbidimeter described in 2.3.C.

C. Laboratory Turbidimeter
1. Not required for this project. Water District has an existing laboratory Turbidimeter that is compatible with equipment specified herein.

D. Calibration Standards
1. Frequency of use of calibration standards determined by recommendation of local regulator.
2. Manufacturer must make available certified calibration standards that can be used in online and bench top instruments for highest calibration accuracy.
3. Calibration standards must be capable of being used to calibrate laboratory turbidimeters with similar optics systems.
4. Calibration standards must be capable of functioning with the instrument's optional RFID module.

2.4 Components

A. Furnish and install the analytical instrument in the following locations:

Equipment Location
Filter Effluent of New Filter No. 7
Filter Effluent of New Filter No. 8

Contractor shall also furnish all necessary items to provide a complete and operable installation. These items include, but are not limited to:
1. Turbidimeter, as specified in section 2.1.A.
2. Mounting bracket
3. Desiccant cartridge
4. User Manual

B. Dimensions: Refer to turbidimeter drawings
Complete Unit Weight: Approximately 5 lbs.

2.5 Instrument Options
NONE

2.6 Instrument Accessories
Bubble trap
Turbidimeter maintenance kit

PART 3 EXECUTION

3.1 Preparation

1. Mounting
   a. As shown on the drawings
2. Inlet and outlet connection sizes
   a. As shown on the drawings

3.2 Installation

A. Contractor shall install turbidimeter only after the shop drawing transmittals have been approved by the Owner/Engineer. Contractor shall provide installation drawings and three (3) copies of the instrument user manual.

3.3 Manufacturer's Service and Start-Up

A. Contractor shall include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.
B. Contractor shall include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.
C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.
D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

SECTION 13401

ONLINE CHLORINE ANALYZING EQUIPMENT

PART 1.0 – GENERAL

1.1 Section includes:
- A. Chlorine analyzer for monitoring of free residual chlorine.

1.2 Measurement Procedures
- A. The method of measuring free or total chlorine will be colorimetric. Instrument chemistry will employ N, N-diethyl-p-phenylenediamine (DPD) method.

1.3 Alternates
- A. Other methods of chlorine measurement such as amperometric, potentiometric, and iodometric that employ electrodes or other electrochemical techniques are not acceptable.

1.4 System Description
- A. Performance Requirements
  1. Measurement range:
     a. 0 to 5 mg/L (ppm) free or total residual chlorine
  2. Accuracy
     a. ± 5% of reading or ±0.03 mg/L (ppm), whichever is greater
  3. Precision
     a. 5% of reading or 0.01 mg/L (ppm), whichever is greater
  4. Minimum detection limit
     a. 0.03 mg/L (ppm)
  5. Resolution
     a. 0.01 mg/L (ppm)
  6. Repeatability
     a. 0.05 mg/L (ppm)
  7. Cycle Time
     a. 2.5 minutes

1.5 Certifications
- A. CE compliant for conducted and radiated emissions CISPR 11 (Class A limits), EMC Immunity EN 61326-1 (Industrial limits), and EN 61010-1
- B. General Purpose UL/CSA 61010-1 with cETLus safety mark
- C. IP62 dust and water ingress protection rating
- D. Australian CTICK and Korean KC Marking

1.6 Environmental Requirements
- A. Operational Criteria
  1. Sample flow rate
     a. 200 to 500 mL/minute

2. Sample pressure (without conditioning kit)
    a. 1 to 5 psi
3. Sample pressure (with conditioning kit)
    a. 120 psi
4. Sample temperature
    a. 41 to 104 °F
5. Operating temperature
    a. 41 to 104 °F
6. Operating humidity
    a. 90% at 40 °C maximum

1.7 Warranty

A. The product supplied for monitoring chlorine level shall include a one-year warranty from the date of shipment

1.8 Maintenance Service

A. Scheduled Maintenance
    1. Monthly
        a. Reagent replacement
    2. Annually
        a. Analyzer tubing replacement
B. Unscheduled Maintenance
    1. Pump tubing replacement is operating temperature dependent
        a. Operating temperature below 80 °F: six-month intervals
        b. Operating temperature above 80 °F: three-month intervals

PART 2.0 – PRODUCTS

2.1 Manufacturer

A. Hach Company, or approved equal
    1. Model CI17 Chlorine Analyzer, Free Chlorine Residual

2.2 Manufactured Unit

A. The chlorine analyzer shall consist of a sample and reagent valve and pump, measurement cell, controller, and is to be shipped with buffer and indicator solutions.

2.3 Equipment

A. The analyzer shall be housed in a NEMA 12 enclosure that is IP62 rated with the gasketed door latched.
B. The analyzer shall be capable of measuring free or total residual chlorine by changing the tubing, indicator and buffer solutions.
C. A measurement shall be taken every 2.5 minutes and results displayed by a three digit LCD readout in the range of 0 to 5 mg/L.
D. The analyzer must operate using 115V or 230V selectable AC power.

E. The analyzer must perform a self-test and auto-blanking between analysis points to compensate for sample color, turbidity, and changes in light intensity due to voltage fluctuations or light source aging.
F. The analyzer shall operate with an LED light source at a peak wavelength of 510nm.
G. The analyzer must be able to operate unattended for 30 days between chemical reagent changes and measurement cell cleaning.
H. The analyzer shall have two feed control (relay) operation modes to operate chemical feed pumps. Control options shall be available to do the following:
    1. On/off control where the concentration alarm outputs activate or deactivate a pump when chlorine levels fall below or exceed acceptable levels.
    2. Proportional control where the 4-20mA output current is scaled to pace a feed pump proportional to output.
I. The analyzer shall be furnished with optically isolated analog outputs, selectable as 0/4 to 20mA, field programmable over any portion of the analyzer range, as standard equipment.
J. The analyzer shall have two standard SPDT relay alarms, with contacts rated for 5 amp resistive loads at 230V AC power. Alarm options should include concentration set point, analyzer system warning, and analyzer system shut down.

2.4 Components

A. Furnish and install the analytical instrument for the following locations:

Equipment Location
Combined Filter Effluent (CFE)
Horse Cave High Service Meter Vault
Magnolia High Service Meter Vault

B. The folowing items shall be included as standard equipment on every analyzer to be furnished:
    1. Cl17 Free Chlorine analyzer
    2. One-Month Supply of reagents
    3. Installation kit
    4. Maintenance kit
    5. Sample conditioning kit
        a. Pressure regulator, strainer, and shut off valve
    6. Wall mount kit
    7. User manual
C. Dimensions: 13.5 x 17.9 x 7 inches

D. Shipping weight: 16 lbs.

2.5 The following analyzer accessories shall also be provided:

A. Power cord for each analyzer
B. Pocket Colorimeter II for free and total chlorine (high and low range combination)

PART 3.0 – EXECUTION

3.1 Preparation

1. Mounting
   a. The Chlorine analyzer shall be wall mounted only, and in accordance with all manufacturers written instructions.
2. Required Clearances
   a. Horizontal: 15.2 in (26 inches ideal)
   b. Vertical: 19 inches
   c. Depth: 20 inches
3. Sample inlet
   a. 0.25 inch OD polyethylene tubing
4. Sample outlet
   a. 0.50 inch ID flexible tubing
5. Overflow drain
   a. 0.50 inch ID flexible tubing
6. Air purge quick connect
   a. 0.25 inch OD polyethylene tubing (optional, see installation detail)

3.2 Installation

A. Contractor shall install the analyzer in strict accordance with the manufacturer's instructions and recommendation.
B. Upon completion of installation, Contractor shall provide a manufacturer's representative to include a half-day of start-up service by a factory-trained technician, if requested.
   1. Contractor shall schedule a date and time for start-up.
   2. Contractor shall have the following people to be present during the start-up procedure.
      a. General contractor
      b. Electrical contractor
      c. Factory trained representative from analyzer supplier
      d. Owner's personnel
      e. Engineer

3.3 Manufacturer's Service and Start-Up

A. Contractor shall include the manufacturer's services to perform start-up on instrument to include basic operational training and certification of performance of the instrument.

B. Contractor shall include a manufacturer's Service Agreement that covers all the manufacturer's recommended preventative maintenance, regularly scheduled calibration and any necessary repairs beginning from the time of equipment startup through to end user acceptance / plant turnover and the first 12 months of end-user operation post turnover.
C. Items A and B are to be performed by manufacturer's factory-trained service personnel. Field service and factory repair by personnel not employed by the manufacturer is not allowed.
D. Use of manufacturer's service parts and reagents is required. Third-party parts and reagents are not approved for use.

END OF SECTION

SECTION 13420

FLOWMETERS

1.0 GENERAL

The Contractor shall furnish all materials, equipment and labor for installing flow-measuring equipment of the type specified herein and as shown on the Drawings.

2.0 EQUIPMENT

2.1 ELECTROMAGNETIC FLOWMETER

Electromagnetic flowmeters shall be installed as shown on the plans and in accordance with the manufacturer's recommendations. The flow meter shall consist of a flow tube (sensor), and a flow transmitter (converter), which shall indicate, totalize and transmit flow data. The flow tube shall use a spool piece configuration with sensors containing coils and electrodes. The electromagnetic flow meter shall be as manufactured by Badger Meter, Inc., or approved equal. The following schedule lists the meters covered under this section:

Location	Meter Use	Meter Size (inches)
Spring Water Pump Station	Service Water Flow & Total	4
Spring Water Pump Station	River Flow & Total	12
Spring Water Pump Station	Spring Flow & Total	16
Chlorine Room	Cl_2 Solution Flow & Total	3
HSPS No. 3 Meter Vault	Magnolia H.S. No. 2 Flow & Total	12

The flowmeter shall maintain a minimum accuracy of +/-0.25% of rate in the velocity range of 1.0 to 33 feet per second (fps). Minimum accuracies for velocities below 1.0 fps shall be better than +/-(0.41/velocity)% of rate.

2.2 FLOW TUBE (SENSOR)

The flow tube body shall be constructed from carbon steel and rated for an operating pressing of 150 psi. End connections shall be with ANSI Class 125 flanges. The exterior shall receive two coatings of an approved epoxy paint system. The interior of the flowmeter shall be equipped with a PTFE liner. The electrodes shall be Alloy C and grounding rings shall be 316 stainless steel. The sensor shall contain an EEPROM storing calibration and factory default settings.

2.3 REMOTE CONVERTER

The flow converter, or meter display/control panel, shall be installed as shown on the plans and in accordance with the manufacturer's recommendations. The converter case shall be either cast aluminum or stainless steel and rated NEMA 4 watertight. Power supply for the flowmeter shall be 120 VAC, 60 Hz. Power consumption will be approximately 24 VA. The converter shall be equipped with an LCD display for showing the flow rate and total flow.

The converter shall be capable of sending a scaleable current and frequency/pulse outputs. The frequency output shall be linearly proportional to rate of flow and shall be capable of being scaleable from 0 to 10 KHz. The pulse output shall be provided with scaleable pulse of 50 to 5000 milliseconds duration, suitable for an electro-mechanical counter for totalization of flow in both forward and reverse direction. The converter outputs shall have individual galvanic isolation with an isolation voltage of more than 500 V.

The converter shall be provided with two internal counters for summation in engineering units of the flow in both directions.

The converter shall be able to detect the following fault conditions and display the faults in the LCD display as well as activate a relay for remote display.

a) Loss of current to the coil.
b) Loss of the load on the current output.
c) Empty pipe.

The converter shall be provided with an error log where all fault conditions occurring within a period of 180 days are stored.

2.4 ADDITIONAL FEATURES

The flowmeter shall include the following features:

- LOCAL DISPLAY & CONTROL KEYS: LCD display (backlit) for showing flow rate, flow total, flow direction, alarms, and faults. Flow data shall be displayed in engineering units (GPM or MGD). The control keys shall be used to set the configuration parameters of the meter.

- ZERO ADJUSTMENT: Zero point adjustment shall be automatic.

- POWER FAILURE: The parameter settings for the flowmeter shall be stored in non-volatile memory and the settings will be restored when power is interrupted.

- SURGE PROTECTION: Surge protectors shall be installed on the power supply and current signal output circuits.

2.5 PRIMARY FLOW ELEMENTS

A differential producing primary flow element(s) shall be installed in the filter effluent piping as shown on the contract drawings, and in accordance with these specifications and the manufacturer's written installation instructions. The flow element shall be of the concentric type, short form, and low head loss type.

The flow element shall be made of cast iron conforming to ASTM A48 Class 30 with the following throat liner:

Bronze ASTM B584 alloy 844 or SEA660, with closed annular pressure chamber at the throat.

The flow element shall be designed to measure potable water over a flow range of 0.56 million gallons per day (MGD) to 1.50 MGD and generate a differential pressure of 117.75 inches at maximum flow.

The uncalibrated accuracy of the primary element shall be within +/- 0.75% of actual flow or +/- 0.25% for a calibrated flow element over the flow range specified with a permanent pressure loss not to exceed 6% of the maximum differential pressure.

The entrance section shell consist of a uniform arc of a circle, the radius of which shall be continuous with the throat. The exit cone shall be designed so as to allow the placement of a controller valve directly on the primary element without affecting the operation or accuracy.

The cast iron flow element shall be a PMT-C Lo-Loss®, as manufactured by Badger Meter, Inc., or approved equal

The following schedule lists the meters covered under this section:

Location	Meter Use	Meter Size (inches)
New Filter Addition Building	Filter No. 7 Effluent Rate-of-Flow Controller	8
New Filter Addition Building	Filter No. 8 Effluent Rate-of-Flow Controller	8

Primary flow elements shall be furnished with all equipment necessary, and with all accessories as shown on drawings, to provide flow measurement information to the respective filter control console(s).

3.0 EXECUTION

3.1 INSTALLATION

Equipment shall be installed as shown on the plans and in accordance with the manufacturer's installation guide.

3.2 START-UP SERVICES

After the equipment is capable of operating, the equipment manufacturer/supplier shall provide competent personnel for a period of one day to check the flowmeter for correct installation, calibration, set-up parameters, and instruction to the Owner’s personnel.

END OF SECTION

SECTION 13500

HOUSED VALVES

1.0 GENERAL

1.1 SCOPE OF WORK

A. Provide all materials, labor, equipment and services required to furnish and install all valves shown on the Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. In-Plant and Vault Piping: Section 13100

B. Yard Piping and Valves: Section 13101

C. Waterlines: Section 13103

2.0 PRODUCTS

2.1 SHEAR GATES

A. Shear gates shall be iron body bronze mounted double wedge type with pull rod and handle. Rod length shall extend 32" above the operating floor level. Shear gates shall be manufactured by M&H, Golden Harvest, Troy, or approved equal. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

2.2 AIR AND VACUUM VALVES FOR VERTICAL TURBINE PUMPS

A. Air valves for Vertical Turbine Pumps shall be designed to allow large quantities of air to escape out the orifice when the pump is started and close watertight when the liquid enters the valve. The air valve shall also permit large quantities of air to re-enter thru the orifice when the pump is stopped to prevent a vacuum from forming in the pump column.

B. The valve shall consist of body, cover, baffle, float and seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, without distortion, and shall be easily removed, if necessary.

C. The entire float and baffle assembly must be shrouded with a perforated water diffuser to prevent the water column entering the valve, from slamming the float shut and eliminate water hammer in the system.

D. The discharge orifice shall be fitted with an adjustable throttling device to regulate the flow of air escaping to establish a pressure loading on the rising column of water to minimize shock to the pump and check valve.

E. The float shall be stainless steel, designed to withstand a minimum of 1000 psi. The float shall be center guided and not free floating for positive seating.

F. Valve may have either threaded or flanged inlet and outlet. The outlet shall be piped to the nearest floor drain.

G. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

H. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

I.

1. Body, Cover & Baffle: Cast iron, ASTM A48 Class 30
2. Float: Stainless Steel, ASTM A240
3. Seat: Buna-N
4. Water Diffuser: Brass, Commercial
5. Throttling Device: Malleable Iron, Commercial

J. Valves shall be manufactured by APCO, Val-Matic, Clay Valve, or equal.

2.3 COMBINATION AIR RELEASE VALVES

A. Combination air release valves (single body, double orifice) shall be designed to allow large volumes of air to escape out the large air vacuum orifice when filling a pipeline and to close watertight when the liquid enters the valve. During large orifice closure, the small air release orifice shall open to allow small pockets of air to escape automatically and independently of the large orifice. The large air vacuum orifice shall also allow large volumes of air to enter through the orifice during pipeline drainage to break the vacuum. The body inlet must be baffled to protect the lower float from direct contact of the rushing air and water to prevent premature valve shut off. The top float must be protected in similar manner for the same purpose. The Buna-N seat must be fastened to the valve cover without distortion for drop tight shut off. All floats shall be heavy stainless steel, hermetically sealed; designed to withstand 1000 psi or more. The upper float shall be center guided for positive shut off. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments. Materials certified to ASTM specifications as follows:

1. Body & Cover & Baffle - Cast Iron
2. Stainless Steel Float

3. Buna-N Seat & Needle
4. Plug & Bronze Forging
5. Delrin Level Frame
6. ASTM A48 Class 30
7. ASTM A240
8. Nitrile Rubber ASTM SB 800
9. ASTM D638

K. Combination air release valves shall be as manufactured by APCO, Val-Matic, Clay Valve, or approved equal

2.4 CHECK VALVES

A. Swing Check Valves: Check valves shall be iron body, bronze mounted, horizontal swing check type, spring loaded suitable for horizontal or vertical service; American Darling, M&H, Henry Pratt or equal. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

B. Double Door Check Valves: Double door check valves shall be as manufactured by APCO, Val-Matic, Henry Pratt or equal. Check valve shall be lug style, pressure class 150 pounds with cast iron body, aluminum bronze doors, T316 stainless steel hinge pin and stop pin, Buna-N set and T316 stainless steel spring. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

C. Silent Check Valves: Silent check valves shall be as manufactured by APCO, Val-Matic, Henry Pratt or equal. Check valve shall be globe style, full flanged body, ANSI Class 125, with cast iron body, bronze seat, stainless steel spring, and bronze bushing. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

D. Air Cushion Swing Check. Air Cushion Swing Check Valve body shall be cast iron per AWWA C508 having integral flanges.

1. The seat shall be centrifugally cast bronze with and o-ring seal and be locked in place with stainless steel lock screws and be field replaceable, without the use of special tools.
2. The shaft shall be single and continuous stainless steel, extending both sides of the body with a lever and weight, using an air cushion cylinder side mounted.
3. The air cushion cylinder shall be constructed of corrosion resistant material and the piston shall be totally enclosed within the cylinder and not open at one end.
4. The cushion cylinder assembly shall be externally attached to either or both sides of the valve body and will permit adjustability to cushion the closure of the valve. Cushioning shall be by air trapped in the cushion

cylinder, which shall be fitted with a one-way adjustable control check valve to cushion disc contact to the seat at the shut-off point.

5. The valve shall prevent backflow of the media on normal pump shut-off or power failure, at zero velocity and be watertight.
6. The disc shall be cast iron utilizing a double clevice hinge connected to a ductile iron disc arm. The disc arm assembly shall be suspended from a stainless steel shaft, which passes thru a seal retainer on both sides of the valve body.
7. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.
8. Materials shall be certified to the following A.S.T.M. Specifications:
   a. Body, Cover, Disc: Cast Iron, ASTM A126, Class B
   b. Disc Arm: Ductile Iron, ASTM A536
   c. Seat: Aluminum Bronze, ASTM B148, or Stainless Steel, ASTM A276
   d. Disc Seat: Buna-N or Metal, to suit
   e. Cushion Cylinder Corrosive Resistant Commercial Steel
9. Valve shall be APCO Series 6000, Val-Matic Tilted Disc with Top Mounted Oil Dashpot, Henry Pratt, or equal.

E. Rubber Flapper Check Valve: The check valve shall be an APCO Series 100, Val-Matic, Henry Pratt or approved equal. This check valve shall have a cast iron body and cover and the body shall be long pattern design with integrally cast on end flanges. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

F. Ball Check Valves: Check valve body shall be cast iron conforming to ASTM A159, Class 35. Check valves shall be rated for 150 psi working water pressure. Check valves shall be furnished with 125# ANSI flanged ends. Ball shall be hollow steel with vulcanized nitrite rubber covering and with a specific gravity greater than 1.0. Check valves shall be constructed to permit entry for complete removal/replacement of internal ball without removing the valve from the line. Valve exterior shall be painted with a primer suitable for severe duty in corrosive environments.

2.5 ELECTRIC CHECK (PUMP CONTROL) VALVES

A. Electric solenoid operated check valves shall be of cast iron body, globe pattern with all bronze or non-corrosive trim construction. The valves shall be flanged, faced and drilled to conform to 250# Stds. B16.1. The electric check valves shall be rated for a normal working pressure of 200 psi. The valve shall be GA Industries Model 1730-D, Ross Model 42 WRS, or approved equal as specified herein.

B. The valves shall be constructed with complete bronze or non-corrosive lining which shall extend down to and form the seat of the valve. The piston shall be bronze. The pilot shall be of the 3-way type and of all bronze construction.

C. The design of the valve shall be such as to provide air and water cushioning to reduce hammer and shock. Speed of valve closing/opening shall be adjustable by a hand operated regulating valve. Wear on valve moving parts shall be absorbed by renewable leather composition or rubber cups and seat. The design of valve shall be such that the area above the piston shall be approximately twice the area on the small end of the piston.

D. The valve shall be designed to provide full pipeline flow when open, and it shall shut off tight, when closed.

E. Valve shall provide for normal automatic opening and closing function, plus emergency closing on electrical outage. It shall also provide for manual-hydraulic control for opening main valve.

F. A mechanical relay pump control panel shall be supplied with each pump control valve. The pump control panel shall be equal to Ross Model CP, GA Industries Model 7600, or approved equal.

G. The Sequence of operation for the electric check valve shall be as follows:

1. Valve opening:
   a. Pump motor starter, three-way solenoid pilot, emergency solenoid pilot simultaneously energized by control circuit.
   b. Valve opens as pump reaches full speed.
   c. Limit switch contacts close interlocking with motor starter circuit.

2. Valve closing:
   a. Three-way solenoid pilot de-energized by control circuit.
   b. Pump motor circuit and emergency solenoid pilot remain energized.
   c. Valve starts to close, pump running.
   d. As piston nears its seat, limit switch contacts open, de-energizing pump circuit and emergency solenoid pilot.

H. In the event of a power failure, the motor starter circuit solenoid operated three-way pilot, and the solenoid operated two-way pilot will become de-energized simultaneously. De-energizing both pilots simultaneously will cause the main valve piston to move rapidly to its seat. The speed of emergency closing is adjustable by regulating valve. The emergency closing speed is always at a faster rate than that of the normal closing speed.

I. The emergency sequence of operation would also pertain in the event of motor under voltage, motor overload, or by depressing the emergency stop button if same is used.

2.6 SURGE RELIEF VALVES

A. The water pressure relief valve shall function to open to atmosphere when the system pressure exceeds the intensity for which the pilot is set. It shall open rapidly, and close slowly at a predetermined rate of speed. Provision shall be made on the valve to regulate the closing speed of the valve.

B. The valve shall be of the angle body or globe body design with inlet pressure entering the valve under the piston. It shall be possible to install the valve in any position without impairing its function.

C. The valve shall be hydraulically operated, designed with a differential type piston such that the piston will expose a greater area to the closing force than to the opening force. A vent to atmosphere from the side of the valve body shall produce the differential piston area, and also serve to provide air cushion to prevent hammer and shock.

D. The body and lid of the valve shall be constructed of high-grade cast iron. Interior parts of the valve, including the piston, liner and seat, shall be of bronze. The liner and piston shall be equipped with renewable leather cups and the piston shall additionally have a leather or rubber seat ring. All wear on the valve shall be absorbed by the cups and seat ring and there shall be no metal to metal contacts within the main valve.

E. The pilot valve shall be of cast bronze conforming to ASTM Specifications B-62. It shall be of the diaphragm operated, spring loaded type, single seated, balanced design. Adjustment of the opening pressure of the main valve shall be accomplished by regulation of the hand wheel on the pilot and shall provide for a range of 20 psi.

F. The valve shall provide full pipeline opening when opened its full stroke, and it shall be drop tight when closed. It shall be possible to open the relief valve at any time by exhausting the pressure from above the piston to atmosphere. The overall body test shall be made hydraulically at a pressure of no less than 50 percent above the maximum working pressure of the valve. The purchaser reserves the right to witness all or any tests, and must be given free access to the place of manufacture at all times. The valve shall be factory tested to relieve at 200 psi.

2.7 PRESSURE REDUCING VALVES (3” and LARGER)

A. The pressure-reducing valve shall maintain a pre-adjusted downstream pressure regardless of changes in flow rate. The pressure-reducing valve shall reduce a high incoming pressure to a lower, constant discharge pressure regardless of variations in flow rate or changes in upstream pressure.

B. The valve shall be ruggedly constructed with a size 12 inches, 125 lb. flanged, full ported globe body design. The pressure reducing valve shall be fully bronze mounted, external pilot operated, with a rugged internal free floating piston (operated without springs, diaphragm or levers), single seat with seat bore equal to size of valve.

C. The minimum travel of the piston shall be equal to 25% of the diameter of the seat. For true alignment, the piston shall be guided above and below the seat a distance no less than 75% of the seat diameter. The piston shall carry a contoured cushion device that will cause a gradual change in flow area as the valve approaches the seat. The cushion device must move with the piston to minimize head loss when the valve is fully opened and so designed as to insure positive closure.

D. The main valve shall be packed with leather for other resilient material to insure tight closure and prevent metal-to-metal friction and seating. The main valve shall include a position indicator to show position of opening of the piston. The main valve will include gauge cocks for testing purposes.

E. The pilot valve, controlling operation of the main valve, shall have a range for adjustment, be easily accessible and so arranged to allow for its removal from the main valve while the main valve is under pressure. The pilot valve and all associated piping and fittings necessary for proper operation shall be factory assembled and furnished with the pressure-reducing valve.

F Ball valves shall be installed in the control piping to completely isolate the pilot valve when conditions may require pilot isolation for maintenance or repair. An external strainer with blow-off will be provided in the control circuit to protect the pilot and needle valves.

G. The design shall be such that repairs and dismantling internally of the main valve may be made without its removal from the line.

2.8 HOUSED GATE VALVES

A. Housed Gate valves, 3" and larger, for fabricated pipe systems shall be resilient sealed, iron body, flanged, fully bronze mounted, and suitable for working water pressures of not less than 250 PSIG. Housed valves shall be

left uncoated to allow painting without the use of tar stop. Valves shall be of standard manufacture and of the highest quality both of materials and workmanship and shall conform to the latest revision of AWWA Specification C-509. Unless otherwise shown on the plans, all housed gate valves shall be non rising stem. Valves shall be rated for a working pressure of not less than 250 psi and shall have flanges drilled 125 lbs. pattern. Unless otherwise shown on the Drawings, housed valves and valves in basins shall be hand wheel operated. Hand wheels shall be ANSI B16.1 Class 125. Hand wheels shall have not less than the following diameters:

Valve Size	Diameter
1"	3 1/8"
1 1/2"	4 1/4"
2"	6"
3"	8"
4"	10"
6"	12"
8"	14"
10"	16"
12"	18"
14"	20"
16"	22"
18"	24"

B. Valve stand hand wheels and hand wheels on extended stems, shall have the same minimum diameters as those shown for hand wheels directly on valves. Extension stems for O.S&Y valves shall be non-rising, with clamp to valve hand wheel and hollow shaft for rising stem of valve, with adjustable cast iron guides per each eight (8) feet of extension stem length maximum. All extension stems shall be connected with suitable coupling castings for connection to and removal from valves and stands. Nuts and bolts on all extension stem connections shall be stainless steel.

2.9 PLUG VALVES

A. Plug valves shall be non-lubricated eccentric type with synthetic rubber faced plugs, corrosion resistant nickel seats, replaceable stainless steel sleeve type bearings in the upper and lower journals. Furnish with flanges faced and drilled ANSI B16.1 125-pound.

B. Valve shall provide drip-tight shut-off up to the full rated pressure. All plug valves shall be provided with limit stops and rotated 90 degrees from fully opened to fully closed. Plug valves shall be manually operated with worm gear operator hand wheel or lever actuated. Plug valves located 6 feet or more above the floor shall be furnished with chain wheel operators.

2.10 HOUSED BUTTERFLY VALVES

A. All butterfly valves shall be of tight closing, rubber or synthetic rubber seat type with seats securely fastened to valve body. No metal-to-metal seating surfaces will be permitted. Valves shall be bubble tight at the rated pressure in either direction and shall be satisfactory for applications involving throttling service and/or frequent operation and for applications involving valve operation after long periods of inactivity.

B. The valve discs shall rotate 90o from the full open position to the tight shut position.

C. The valve bodies themselves shall be one-piece construction of the flanged type design except where specifically noted on the Drawings. Valve bodies shall be constructed of cast iron ASTM A 126, Class B, and shall be suitable for use with 125# ANSI flanges. Valves shall meet the full requirements of the applicable classes of AWWA C504.

D. The valve discs shall be cast iron or ductile iron with a 316 SS edge extending the full width of the disc. The disc-to-shaft connections shall be via polished 316 SS pins. Sprayed or plated discs are not acceptable. All disc seating edges shall be smooth and polished.

E. The shafts shall be turned, ground and polished. They shall be 300 Series Stainless Steel with diameters per AWWA Specification C504, Class 150B. The shafts shall be of one-piece construction.

F. The shaft seals shall be of Hycar material and of the self-adjusting wear-compensating design.

G. The valve bearings shall be nylon, Teflon fiberglass, or stainless steel basket design and construction.

H. The valve seats shall be Hycar Buna-N and EPDM and shall be simultaneously molded, vulcanized, and fully bonded to the valve body.

I. All surfaces of the valve shall be clean, dry and free from grease before painting. The valve surfaces except for disc, seating and finished portions shall be evenly coated at the factory with a suitable rust inhibitive primer. Hydrostatic and leakage tests shall be conducted in strict accordance with AWWA C 504.

J. The valves shall be manufactured by Dezurik, Henry Pratt, Crispin, or approved equal.

K. Manually Operated Butterfly Valves. Manually operated valves shall be operated using a cast iron hand wheel or chain wheel for valves located 7 feet above the floor level. All units shall have adjustable open and close position stops and valve position indicator. Operators shall meet the requirements of AWWA C-504, Section 4.5.8.5.

1. Manually operated butterfly valves shall be furnished and installed as shown in the contract drawings.

L. Electric Valve Actuators.

1. GENERAL – Electric actuator shall include the electric motor, reduction gearing, valve stem drive nut/bushing, position limit switches and mechanical overload torque switches. Gear housing shall be hard anodized, high-grade aluminum gear case with an internal and external polyester coating. An automatic declutchable handwheel shall be provided. Failure of actuator motor shall not prevent handwheel operation of the actuator nor shall the motor cause the handwheel to rotate during normal operation. All control covers shall have o-ring seals and conform to NEMA 4X and IP67 standards.

2. GEARS – Motor speed reduction shall be by means of a gear train consisting of hardened steel spur gears and self-locking worm and worm gear sets. The worm shall be heat-treated alloy steel and have worm thread surface rolled or ground. The worm gear shall be bronze. Non-metallic gears in the power train are not acceptable.

3. LUBRICATION – All gearing and bearings shall be grease lubricated and suitable for year-round service based on prevailing ambient temperature conditions.

4. MOTORS – Electric motors shall be single phase 120 volt. Motors shall be protected with thermal overload sensors imbedded in the motor windings.

5. SWITCHES – Four (4) SPDT limit switches and two (2) SPDT torque switches, which are rated for 10 Amps at 250 VAC, shall be provided, as a minimum.

6. Position Indication – A valve position indication dial display shall be provided. The dial window design shall prevent the pooling of water on the display.

7. Manufacturers –The actuator shall be model HQ as provided by EIM Controls, or approved equal.

8. Local and Remote Reversing Controls – Actuators shall include as a minimum Open/Close and Local/Off/Remote Switches; (5) LED lights

indicating: Power On (White), Remote (Blue), Fault (Yellow), Open (Red), Close (Green), Blinking Red/Green lights shall indicate valve Opening/Closing.

a) Termination points shall be provided to give remote indication of the above listed light functions. A 24 Point Terminal Strip shall be provided for field wiring.

9. Modulating Controls – When analog control is required a Proportional Control Unit (PCU) shall provide control and position feed back. The PCU shall accept input signals of: 4-20 mA. The output signal shall be 4-20 mA.

10. Operating Torque – The actuators shall provide the following torque;

Valve Size (inches)	Torque (in-lbs)
2”	130
3”	205
4”	330
6”	745
8”	1,890
10”	3,305

Valve Size (inches)	Torque (in-lbs)
12”	3,955
14”	5,350
16”	7,430
18”	9,920
20”	12,610
24”	19,830

For actuators installed on modulating valves, the torque specified in the above tables shall be increased by a factor of 1.3.

2.11 FLAP VALVES

A, Flap Valves shall be of the circular port design with offset single pivoted hinge. The assembly shall consist of four components: flap gate, body, seat, and hinge pin. The flap gate and body shall be cast iron conforming to ASTM A-126 Class B. The seat and hinge shall of bronze construction. The flap gate seat ring shall be rolled into a dovetailed groove under pressure to make a single inseparable unit. The seat shall be threaded into the body.

2.12 SWING PIPES

A. The swing pipes in size shown on the Drawings are to be fabricated from Class 50, ductile cast iron pipe. The swing connection shall be a flanged stainless steel 90` swivel joint Style 30 as manufactured by Chicksan Weco, or equal. The swing pipes shall be controlled by 1000 lbs. capacity enclosed worm gear winches with 1/4" stainless steel cable. The winch supports shall be fabricated from structural steel and shall be equipped with 1/4" winch support plates.

2.13 PRESSURE RELIEF VALVES, WALL TYPE

A. Pressure Relief Valves shall be of the vertical seat design with offset single pivoted hinge. The assembly shall consist of five components: flap gate, body, gate seat retainer plate, hinge pin, and body seat ring. The flap gate, body, and gate seat retainer plate shall be cast iron conforming to ASTM A-126 Class B. The seat and hinge shall of bronze construction. The gate shall have a neoprene rubber seat cemented and mechanically retained in place by a cast iron retainer plate. The body seat ring shall be threaded and screwed into place and the face machined to a smooth finish.

2.14 MUD VALVES

A. Mud valves shall be of the iron body, bronze mounted type with non-rising stems, and flanged ends. Pedestals, or floor stands, and extension stems may be required as shown on the contract Drawings.

B. The frame, yoke and gate shall be sturdily proportioned for strength and rigidity and be of cast iron conforming to ASTM specifications A126 Class B.

C. The stem, stem nut and seats shall be bronze. The stem shall be machined with accurately cut modified acme threads. Stem extensions shall be stainless steel.

D. The gate seat shall be rolled into a dovetailed groove under pressure to make one inseparable unit. The body (frame) seat ring shall be threaded and screwed into place in the frame. Both gate and body seat ring faces shall be machined to a smooth finish. The valve body, frame, yoke, and gate shall be painted with two coats, 4 mils each, of coal tar epoxy.

2.15 TELESCOPING VALVES

A. The telescoping valve shall be of stainless steel construction, type 304, and consist of the following components: tube, seal flange, gasket, lifting bail, lift, and stem.

B. The tube shall be constructed from stainless steel seamless tubes, or pipe, and the finished outside diameter of the tube is to be +/- .04 inches, cylindrical within .100 TIR. The tube surface shall be smooth, 125 micro inches or better. Tube lengths shall be of sufficient length to facilitate valve travel and maintain an appropriate insertion depth. Valve tubes are to be a minimum 1/8” thick and are attached to connecting stems by use of a lifting bail.

C. The valve manufacturer shall provide a stainless steel companion flange and neoprene slip seal gasket. The gasket must be a minimum of ¼” thick. The

inside diameter of the gasket is to be 1/8” smaller than the outside diameter of the valve tube to provide a friction seal. The gasket is to be sandwiched between the riser pipe flange and the companion flange. The gasket and companion flange shall include a 125# standard drilling pattern to match the riser pipe. Bolts shall be stainless steel.

D. The lifting bail shall be of stainless steel construction and be rigidly welded to the tube.

E. Lifts shall be pedestal/hand wheel type with UHMW polyethylene thrust bearings along with an acme threaded type 304 stainless steel stem to provide automatic self-locking, infinite valve positioning. The rising stem lift shall use a galvanized steel square tube with torque nut design to prevent telescoping valve tube rotation. Hand wheels shall be sized to limit the pull on the rim to 40 pounds. Pedestals shall include a clear plastic Butyrate stem cover with a mylar strip type position indicator, calibrated in ¼” increments to illustrate valve position. The mylar strip, provided by the manufacturer, will be affixed by the contractor after installation to provide a true and accurate indication of the tube elevation by comparing it to the top of the rising stem. Stainless steel anchor bolts shall be provided for all pedestals. Pedestals and hand wheels shall be constructed from cast iron conforming to ASTM A126 Class B. Cleaning and shop prime coat of pedestals and hand wheel will be as specified in Division 9.

2.16 KNIFE GATE VALVES

A. The valve body and chest shall be solid one piece cast from type 304 stainless steel. Valves larger than 24” may have their body fabricated with stainless steel. The valve’s flanges, gate, yoke, stem, packing follower, and fasteners shall be stainless steel. Packing shall be acrylic/PTFE. Valves shall have a minimum pressure rating of 50 psi and comply with MSS-SP-81 specification.

B. Pedestals, handwheels, stem extension, right-angle gear drives, etc. shall be furnished as shown on the Drawings.

2.17 SILENT CHECK VALVES (GLOBE STYLE)

A. Globe style Silent Check Valve shall be designed with semi-steel bodies, bronze seat, bronze plug and stainless steel spring. The valve plug must be center guided at both ends with a thru integral shaft and spring loaded for guaranteed silent shut-off operation. The spring must be helical or conical. The seat and plug shall be hand replaceable in the field for ease of maintenance. The flow area thru the body shall be equal to or greater than the cross-sectional area of the equivalent pipe size.

B. All materials of construction shall be certified in writing to conform to A.S.T.M. specifications as follows:

1.	Body:	Cast Iron, ASTM A48, Class 30
2.	Plug and Seat:	Bronze, ASTM B584
11.	Spring	Stainless Steel, T302
12.	Exterior Paint:	Phenolic Primer, NSF Approved for Potable

2.18 FLANGE COUPLING ADAPTER (FCA)

A. Flange Coupling Adapters (FCA) shall be used in lieu of threaded or welded flanged spool pieces. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C115/A21.15. Restraint for the flange adapter shall consist of a plurality of individually actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of the gripping wedges. The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal. For PVC pipe, the flange adapter will have a pressure rating equal to the pipe. For Ductile Iron Pipe, the flange adapter shall have a safety factor of 2:1 minimum.

2.19 PEDESTALS/FLOOR STANDS

A. The Contractor should attempt to obtain the pedestals from the valve manufacturers to minimize any confusion concerning the compatibility of various products. In lieu of the valve manufacturer's standard pedestals, the Contractor may furnish the pedestals as manufactured by M&H Style F-5500/5510, FastFab, or approved equal. The pedestals shall be of cast iron construction; ASTM A126 Class B. Extension stems shall be stainless steel for submerged applications and epoxy coated steel for standard installations. Pedestal base shall be a minimum of 12 inches square. Hand wheels shall also be cast iron with a minimum diameter of 12 inches.

2.0 EXECUTION

2.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 14620

HOIST AND TROLLEY

1.0 GENERAL

1.1 SCOPE OF WORK

The CONTRACTOR shall furnish all labor, tools, equipment, materials, and perform all work and services necessary for or incidental to the furnishing and complete installation of the hoisting equipment as shown on the drawings and as specified in accordance with provisions of the contract documents and completely coordinated with that of all other trades.

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, complete, and compatible installation shall be furnished and installed as part of this work.

This section describes the hoist systems including hoists, trolleys and trolley beams to be installed in the locations shown on the Drawings and described herein. Beams shall be provided and installed as part of the structural steel. The Contractor shall coordinate as required.

1.2 QUALITY ASSURANCE

The overhead hoists shall conform to the following standards.

A. Hoist Manufacturer's Institute (HMI)
B. American National Standards Institute (ANSI)
C. National Electrical Code (NEC)
D. American Society of Mechanical Engineers (ASME)
E. Comply with CSA Standards
F. ASME/ANSI B30.16, Safety Standards for Overhead Hoists (Underhung).
G. Lifetime warranty against defective material and workmanship

2.0 EQUIPMENT

2.1 ELECTRIC CHAIN HOIST AND MOTORIZED TROLLEY

A. Electric Chain Hoist. The Contractor shall provide an electric chain hoist with hook mount and 75 foot power cord for operation. A guide wire kit shall be included for this installation. The electric chain hoist shall be similar to the (N)ERM020LD-L/S series as manufactured by Harrington, or approved equal.

The hoist shall have a completely sealed, compact aluminum body and come equipped with an extreme duty motor, pull-rotor motor brake, chain guide, friction clutch and heat treated helical and spur gears.

The motorized trolley shall be designed to mount on the beam shown on the plans. Trolley wheels to be hardened steel. Trolley to include drop stops, rubber bumpers, side guide rollers and a completely sealed body suitable for harsh indoor or outdoor environments (IP55 rated).

The chain shall be grade 80 nickel-plated with carbon steel hooks. The bottom hook shall swivel 360 degrees.

The electric chain hoist shall have an easy maintenance control panel with fast on-site access and hinged cover, single swing-out panel and a simple layout of controls.

B. Electric Chain Hoist Schedule.

	Chlorine Building
Capacity	2 tons
Net Hoist Weight	256 lbs.
Lift Motor Output	2.4 Hp
Lift Motor Voltage/Phase	208-230v / 3 ph
Lift Motor Amperes	8.6 amps
Trolley Motor Output	0.54 Hp
Trolley Motor Voltage/Phase	208-230v / 3 ph
Trolley Motor Amperes	3.2
Traversing Speed (max.)	80 fpm
Lifting Speed (max.)	14 fpm
Headroom (max.)	24 in.
Lift Length (min.)	10 ft.

C. Chain Container. The Contractor shall provide and install a chain contained that is integrally mounted under the hoist. Container to be properly sized for the chain length specified for the hoist.

D. Cable Festoon System. The Contractor shall provide a standard C-Track Festoon system for the electric cable powering the hoist with motorized trolley. Cable festoon system shall be as manufactured by Magnetek, or approved equal.

3.0 SUBMITTALS

3.1 SHOP DRAWINGS

A. Submit shop drawings for hoists showing all accessories with specific dimensions on drawings.

B. Submit manufacturers' informative literature on hoists and accessories, to include standard data sheet, brochures and dimensional drawings of the equipment for approval.

C. Indicate any required field dimensions.

D. Submit Operation and Maintenance manuals for hoist and trolley.

3.3 MAINTENANCE INSTRUCTIONS

Submit information on required maintenance and repair procedures for electric hoist. Include location of nearest repair facilities for all equipment.

3.4 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Submit manufacturer's assembly and installation instructions to the Engineer for review.

4.0 INSTALLATION

The Contractor shall furnish and install hoists where indicated on the Drawings. Hoist shall be installed in accordance with the manufacturer's recommendation.

END OF SECTION

SECTION 15010

GENERAL HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals necessary to provide a complete and operational mechanical system as shown on the Drawings and as specified herein.

B. Installation of equipment that has not been specifically detailed in the Drawings shall be installed per that equipment manufacturer's recommended installation instructions or industry Standard Methods. All hardware and materials required for said equipment installation shall be included in the bid price.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including General Supplementary Conditions and Divisions 0 and 1 Specification sections, apply to work of this section. Additional work incidental to the Mechanical System work shall be done under other Sections of the Specifications. Carefully review the entire contents of the bidding documents.

1.03 PROTECTION OF MATERIALS, WORKS, AND GROUNDS

A. Materials, fixtures, and equipment shall be properly protected and all pipe openings shall be temporarily closed so as to prevent obstruction and damage.

B. Protect and preserve all materials, supplies, and equipment of every description and all work performed. Damages shall be repaired or replaced promptly at no additional cost to the Owner.

1.04 CLEANING

A. During the progress of the work, clean up and remove all oil, grease, and other debris. At completion, clean all equipment, piping, and duct systems, remove all stickers, non-permanent tags, and leave work in perfect operating condition.

1.05 DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale, but figures, dimensions, and detailed drawings are to be followed in every case. The Drawings shall be taken in a sense as diagrammatic. Size of pipes and ducts and methods of running them are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the true intent and purpose of the Drawings, all necessary parts to make complete working systems ready for use shall be furnished without extra charge. All work shall be installed in such a manner to avoid being unsightly.

B. Locations of equipment and piping shown on the Drawings are approximate, and it is intended that all equipment shall be located in accordance with the general and detail Drawings of the construction proper. All measurements shall be taken at the site. Utilize only dimensioned architectural drawings for laying out work. Scaling of drawings for field work is unacceptable.

1.06 CODES, ORDINANCES, STANDARDS

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC) and its references. Whenever and wherever state laws and/or regulations and/or the Engineer's design requires a higher standard than the current Code, then these laws and/or regulations and/or the design shall be followed.

B. Contractor's performing HVAC work or plumbing work shall be licensed in the State of Kentucky.

C. All refrigeration systems work shall conform to ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration."

1.07 FEES/PERMITS

A. Contractor shall be responsible for all permit fees unless otherwise noted.

B. Obtain all required permits, pay all fees for the same, and in general, take complete charge and responsibility for all legal requirements pertaining to this Section of the work.

1.08 LABELING

A. All mechanical equipment and items utilizing electrical components shall be UL or ETL listed for the application, where a listing exists. Other code

accepted independent testing laboratory certification will be accepted as equivalent to UL.

1.09 COOPERATION WITH OTHER TRADES

A. The work will be so performed that the progress of the entire building construction including all other trades, shall not be delayed nor interfered with. Materials and apparatus shall be installed promptly when and as desired.

B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Refer to the General Conditions for Dispute Resolution Requirements. All work and materials placed in violation of this shall be readjusted to the Engineer's satisfaction at no expense to the Owner.

C. Where work of this Section will be installed in close proximity to work of other Sections or where there is evidence that the work of this Section will interfere with work of other Sections, assist in working out space conditions to make satisfactory adjustment. If so directed, prepare and submit for approval 1/4-inch scale or larger working drawings and sections, clearly showing how this work is to be installed in relation to the work of other Sections. If the work of this Section is installed before coordinating with other trades or so as to cause interference with work of other trades, make changes necessary to correct conditions without extra charge.

1.10 REVIEW OF MATERIALS

A. The Engineer shall be notified by letter one week after the preconstruction meeting of any materials that have a delivery lead time of over six weeks.

1.11 SUBMITTALS

A. Submit to the Engineer for review, as provided in the General Conditions, the manufacturer's shop drawings and technical literature covering details and installation of all new equipment, fixtures, and accessories being furnished under this Section prior to fabrication, assembly, or shipment.

B. Shop drawings will be required on all materials specified throughout individual Sections of this Division. Refer to individual technical sections for additional submittal requirements.

C. Shop drawings shall be submitted only after the Contractor has checked and verified all field measurements, quantities, equipment dimensions, specified performance criteria, installation requirements, electrical requirements, materials, catalog numbers, and similar data with respect thereto and reviewed or coordinated each shop drawing with the requirements of the work and the Contract Documents.

D. At the time of each submission the Contractor shall give the Engineer specific written notice of each variation that the shop drawings may have from the requirements of the Contract Documents.

E. The shop drawings shall have a stamp or specific written indication that Contractor has satisfied the requirements stated herein before. Shop drawings submitted without the Contractor's review stamp shall be immediately returned to the Contractor without the Engineer's review.

1.12 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list. Also included shall be all of the shop drawing catalog data with highlighted options, model codes, etc.

C. O & M Manuals shall be available to the Owner prior to equipment training commences.

D. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

E. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies.

1.13 POWER SUPPLY

A. Refer to Division 16 and the Contract Drawings (except as noted herein).

1.14 SITE VISIT

A. It shall be the responsibility of the bidder to visit the site before submitting his bid, and thoroughly note the conditions under which the work will be installed. No extra compensation will be later allowed for necessary work not figured that should have been foreseen.

1.15 REMOVAL OF EXISTING EQUIPMENT

A. De-energize, remove and dispose off the site the equipment noted to be demolished on the Contract Drawings.

1.16 MECHANICAL DEMOLITION

A. See general mechanical demolition notes on the Architectural, Mechanical, and Electrical demolition drawings for requirements. Additional notes for cutting and patching are noted below.

1.17 ACCEPTANCE

A. After the various systems are completed and at which time the Engineer shall deem appropriate, the Contractor shall run an operation test for acceptance of each system. The Contractor shall adjust all valves, equipment, controls and accessories so as to obtain maximum operating efficiency. Failure of any component to perform as specified shall constitute cause for rejection and removal. The Contractor shall instruct the Owner's representative in the operation of the system. See individual technical sections for additional requirements.

1.18 NOISE AND VIBRATION

A. Install vibration isolators, flexible connectors, expansion joints, and other safety measures to prevent noise and vibration from being transmitted to occupied areas. Equipment shall be selected to operate within the noise level recommended for the particular type installation in relation to its location.

B. Following installation, make proper adjustments to eliminate excessive noise and vibration.

1.19 CUTTING AND PATCHING

A. Cutting and patching shall be held to an absolute minimum, and such work shall be done only under the direction of the Engineer/Architect. The Contractor shall be responsible for and pay for all openings that may be required in the walls, floors, and roofs, to accommodate the work, and shall be conducted at the project site by qualified representative of the manufacturer.

B. Contractor must first locate concealed concrete steel prior to core drilling. Cutting of concrete reinforcing steel is not allowed. Steel can be located with appropriate investigative testing equipment.

C. Prior to cutting of any floors or walls, all conduits must be located prior to the cutting through the use of sounding test equipment. Such equipment is readily available through rental companies and other sources. If a pipe or electrical circuit is damaged during cutting/demolition the Contractor shall repair the damaged item back to original condition. Absolutely no extras will be allowed for the replacement of damaged electrical conduits, pipes, etc. in floors, walls, and ceilings that are to remain.

1.20 OWNER TRAINING

A. All manufacturers supplying equipment for this division shall provide the Owner's operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer.

B. The cost of this training shall be included in the bid price.

C. The required training shall consist of both classroom and hands-on situation. Classroom training shall include instruction on how the equipment works, its relationship to all accessories and other related units, detailed review of shop drawings, detailed presentation of written O&M instructions, troubleshooting and record-keeping recommendations. Hands-on training shall include a review of the manufacturer's O&M instructions, check out of each operators identifying key elements of the equipment, tear down as appropriate, calibration, adjustment, greasing and oiling points, and operating manipulations of all electrical and mechanical controls.

D. The training shall be scheduled through the Contractor with the Owner. The timing of the training shall closely coincide with the startup of the equipment, but no training shall be conducted until the equipment is operational.

E. The minimum number of training hours to be provided by manufacturers supplying equipment on this project are noted in the individual Specification Sections for said equipment.

F. At least 14 days prior to the training the manufacturer shall submit through the Contractor to the Engineer an outline of the training proposed for the Engineer's review and concurrence. The Owner reserves the right to videotape all training sessions.

1.21 RECORD DRAWINGS

A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these drawings, from day to day, the actual "as built" record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

1.22 WARRANTY

A. Contractor shall refer to the General Conditions for warranty requirements. Other items of equipment specified throughout Division 15 may have longer/special warranty requirements - see individual equipment specifications.

B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is considered as routine. (That is replacement of filters, oiling, greasing, etc.) The Engineer shall be the judge of what shall be considered routine maintenance.

1.23 SEISMIC CONSIDERATIONS

A. Refer to seismic category in Architectural/Structural Drawings and provide necessary supports and provisions to meet all applicable codes.

1.24 ENVIRONMENTAL

A. Contractor shall not use any materials that contain asbestos, lead, or PCB's.

B. In the event the Contractor encounters material reasonably believed to be asbestos or polychlorinated biphenyl (PCB) on the site, which has not been rendered harmless, the Contractor shall immediately stop work in the area affected and report the condition to the Engineer and the Owner's Representative. The work in the affected area shall not thereafter be resumed. The Contractor shall not be required to perform any work relating to asbestos or polychlorinated biphenyl (PCB).

1.25 COOPERATION

A. Cooperate with other trades to obtain the most practical arrangement of work. Become familiar with drawings before starting work.

B. Make known to other trades intended positioning of materials and intended order of work. Coordinate work with other trades and proceed with the installation to assure no delays to other trades. Determine intended positions of work of other trades and intended order of installation.

1.26 WORKMANSHIP

A. Work shall be performed only by mechanics and tradesman skilled and working within their respective trades and shall present appearance typical of the best trade practices. Work not installed in this manner shall be repaired, removed or replaced, or otherwise remedied at Contractor's expense as directed by Engineer.

1.27 ORDER OF WORK

A. Contractor shall organize work to cause least disturbance possible to operation of any building, service or system on site. When necessary to interrupt services, time of interruption shall be approved by Owner. Contractor must include in bid any overtime necessary to complete the work within the Contract schedule. Work shall be scheduled to coincide with and cause the least possible disturbances to other contractor's work and schedules.

1.28 EXCAVATION

A. Not applicable for the HVAC system on this project.

1.29 ACCESS DOORS TO EQUIPMENT

A. All equipment shall be accessible.

1.30 CONDENSATE DISPOSAL

A. Condensate piping shall be copper and shall be sloped ¼" per foot.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION

SECTION 15120

MECHANICAL PIPE SEALS

PART 1.0 – GENERAL

Under this section, the contractor shall provide a complete mechanical pipe seal assembly as shown on drawings. Mechanical pipe seals shall be used on all pipe penetrations into cast-in-place concrete basin walls and floors.

A. Wall (Floor, Ceiling) opening (i.e. steel sleeve, Thermoplastic (HDPE) sleeve, cored hole or formed hole). The wall opening size shall be as indicated on the drawings.
B. A sufficient quantity and type of mechanical seals required to effectively provide a hydrostatic and/ or fire-rated seal.
C. Each individual link must be conspicuously and permanently identified with the name of the manufacturer and model number. Manufacturers must submit detail drawings of their proposed equipment and suitable evidence of a minimum of 10 years of experience in providing modular pipe seals. All submittals shall be in accordance with the contract General Conditions and Section 1 specifications.

PART 2.0 – PRODUCTS

Pipe seals shall be modular, mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening. The elastomeric element must be sized and selected per manufacturer's sizing procedure and have the following properties as designated by ASTM. Coloration must be throughout elastomer for positive field inspection. Each link must have a permanent identification of the size and manufacturer's name molded into it. Pipe seals to be as manufactured by LINK-SEAL by GPT Industries, or approved equal.

A. Standard Service Applications = Model C
   -40 to +250 ºF, EPDM = ATSM D2000 M3 BA510 Color = Black
B. Potable Water/NSF 61 Service Applications = Model S61
   -40 to +250 ºF, EPDM = ATSM D2000 M3 BA510 Color = Black
C. Thin Walled Pipe Applications = Model L
   -40 to +250 ºF, EPDM = ATSM D2000 M3 BA510 Color = Blue
D. Hydrocarbon Service Applications = Model O
   -40 to +210 ºF Nitrile = ASTM D2000 M1BF510 Color = Green
E. High Temperature or Fire Seal Applications = Model T
   -67 to +400 ºF Silicone = ASTM D2000 M1GE505 Color = Gray

Reference must always be made to the latest published modular seal selection guide for the service intended.

2.1 MODULAR SEAL PRESSURE PLATES

A. Modular seal pressure plates must be a uniform pressure plate design molded of glass reinforced Nylon Polymer with the following properties:
   Izod Impact - Notched = 2.05ft-lb/in. per ASTM D-256
   Flexural Strength @ Yield = 30,750 psi per ASTM D-790
   Flexural Modulus = 1,124,000 psi per ASTM D-790
   Elongation Break = 11.07% per AST M D-638
   Specific Gravity = 1.38 per ASTM D-792

B. Pressure plates must incorporate the most current modular seal design modifications and include an integrally molded compression assist boss on the top (bolt entry side) of the pressure plate, which permits increased compressive loading of the rubber sealing element. Pipe seals for penetrations larger than 6" diameter must incorporate an integral recess known as a "Hex Nut Interlock" designed to accommodate commercially available fasteners to insure proper thread engagement for the class and service of metal hardware. All pressure plates must have a permanent identification of the manufacturer's name molded into it.

C. For fire and hi-temperature rated services, pressure plates must be steel with 2-part Zinc Dichromate Coating.

2.2 MODULAR SEAL HARDWARE

All fasteners must be sized according to latest modular seal technical data. Bolts, allen head/flange hex nuts must be 316 Stainless Steel per ASTM F593-95, with an 85,000 psi average tensile strength.

PART 3.0 – QUALITY ASSURANCE

Modular Seal components and systems shall be domestically manufactured at a plant with a current ISO 9001:2008 registration. A copy of ISO 9001:2008 registrations shall be a submittal item.

PART 4.0 – PAYMENT

No separate measurements or payment will be made for the mechanical pipe seals. Payment for this item shall be included in the work to which it is subsidiary in the Bid Schedule.

END OF SECTION

SECTION 15145

HVAC HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install all hangers and supports for duct, piping, and equipment as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 15 HVAC Ductwork

B. Drawings and general provisions of the Contract, including the General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.03 SUBMITTALS

A. Submittals: Submit product data and shop drawings according to the Conditions of the Contract and General Mechanical Requirements of these specifications.

1.04 QUALITY ASSURANCE

A. Listing and Labeling: Provide hangers and supports that are UL listed and labeled as defined in NFPA 70, Article 100.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Hangers, Supports, and Components: Factory-fabricated according to MSS SP-58.

1. Components shall be galvanized and painted or shall otherwise be stainless steel (or copper for copper piping).

2. Pipe attachments shall include nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Thermal-Hanger Shield Inserts: 100-psi average compressive strength, waterproofed calcium silicate, encased with sheet metal shield. Insert and shield cover entire circumference of pipe and are of length indicated by manufacturer for pipe size and thickness of insulation.

C. Duct hanging materials shall be strut with threaded rod supports or similar fabricated support system. The use of metal strips or cable hanging systems to support ductwork is not acceptable

PART 3 - EXECUTION

3.01 INSTALLATION

A. Specific hanger requirements are specified in the Section specifying the equipment and systems.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping specification Sections. Refer to hanger spacing schedule on the Drawings.

C. Comply with MSS SP-69 and SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

D. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible.

E. Install supports with maximum spacings complying with MSS SP-69.

F. Where pipes of various sizes are supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

G. Install building attachments to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

I. Heavy-Duty Steel Trapezes: Field-fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

J. Install hangers and supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so that maximum pipe deflections allowed by ASME B31.9 "Building Services Piping" is not exceeded.

M. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.

2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Shields: Install MSS Type 40, protective shields on cold piping with vapor barrier. Shields span an arc of 180 degrees and length as required to accommodate pipe movement caused by expansion and contraction.

4. Insert Material: Length at least as long as the protective shield.

5. Thermal-Hanger Shields: Install with insulation of same thickness as piping.

N. Fabricate structural steel stands to suspend equipment from structure above or support equipment above floor.

O. Grouting: Place grout under supports for equipment, and make a smooth bearing surface.

P. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

END OF SECTION

SECTION 15182

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide refrigerant piping as indicated on the Contract Drawings, as required by the heat pump manufacturer, and as specified herein.

B. Comply with HVAC equipment manufacturer’s requirements for refrigeration systems.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

B. Related Sections include the following:

1. Insulation is specified in Section 15250 HVAC Insulation.

1.03 SUBMITTALS

A. Submit in accordance with Section 15010 and the General Conditions of this Contract.

B. Product Data – Furnish manufacturer's standard catalog data for all equipment to be installed, highlighted to show material, size, options, performance charts and curves, etc. in adequate detail to demonstrate compliance with Contract requirements. Data shall include manufacturer's recommended installation instructions and procedures.

C. Operation and Maintenance Manuals – Furnish O&M manuals in 3-ring hard-back binders which include complete shop drawing data along with test reports, operation instructions, maintenance instructions, and as-built piping and wiring diagrams.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Stored items shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper

protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, piping and similar openings shall be capped to keep out dirt and other foreign matter.

1.05 PROJECT/SITE CONDITIONS

A. Verification of Dimensions: The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing any work.

B. Contract Drawings: Because of the small scale of the Drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

PART 2 - PRODUCTS

2.01 STANDARD COMMERCIAL PRODUCTS

A. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. Products shall be supported by a service organization. System components shall be environmentally suitable for the indicated locations.

2.02 ELECTRICAL WORK

A. Electrical equipment and wiring shall be in accordance with Division 16. Field wiring shall be in accordance with manufacturer's instructions. Manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, shall be provided.

2.03 REFRIGERANT PIPING SYSTEM

A. Refrigerant piping, valves, fittings, and accessories shall be in accordance with ASHRAE 15 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and

temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant.

2.04 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

A. Copper tubing shall conform to ASTM B 280 annealed or hard drawn as required. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required. Soft annealed copper tubing shall not be used in sizes larger than 1-3/8 inches. Joints shall be brazed except that joints on lines 7/8 inch and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B 62. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B 75M ASTM B 75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

B. Solder - Solder shall conform to ASTM B 32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B 813.

C. Brazing Filler Metal - Filler metal shall conform to AWS A5.8, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.05 VALVES

A. Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves shall have brazed or socket welded connections. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

B. Refrigerant Stop Valves - Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve

packing shall be replaceable under line pressure. Valve shall be provided with a operator and a seal cap.

C. Check Valves - Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provided with resilient seat.

D. Liquid Solenoid Valves - Valves shall comply with ARI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

E. Expansion Valves - Valve shall conform to ARI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 1 degrees C (2 degrees F) 2 degrees F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

F. Safety Relief Valves - Valve shall be the two-way type, unless indicated otherwise. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

G. Evaporator Pressure Regulators, Direct-Acting - Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 degrees F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

H. Refrigerant Access Valves - Refrigerant access valves and hose connections shall be in accordance with ARI 720.

2.06 PIPING ACCESSORIES

A. Filter Driers - Driers shall conform to ARI 710. Sizes 5/8 inch and larger shall be the full flow, replaceable core type. Sizes 1/2 inch and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down and shall remove water, acid, and foreign material from the refrigerant. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

B. Sight Glass and Liquid Level Indicator

1. Assembly and Components - Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type. Ferrous components subject to condensation shall be electro-galvanized.

2. Gauge Glass - Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

3. Bull's-Eye and Inline Sight Glass Reflex Lens - Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipe line mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

4. Moisture Indicator - Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

C. Vibration Dampeners - Dampeners shall be of the all-metallic bellows and woven-wire type.

D. Flexible Pipe Connectors - Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 150 degrees C (300 degrees F) 300 degrees F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

E. Strainers - Strainers used in refrigerant service shall have brass or cast iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

F. Pressure and Vacuum Gauges - Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3-1/2 inches in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

G. Temperature Gauges - Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Celsius scale in 1 degree Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor.

1. Stem Cased-Glass - Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2. Bimetallic Dial - Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

3. Liquid-, Solid-, and Vapor-Filled Dial - Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

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4. Thermal Well - Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

H. Pipe Hangers, Inserts, and Supports - Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69. They shall be copper or galvanized and painted.

2.07 FABRICATION

A. Equipment shall have weather resistant finishes that will withstand 500 hours exposure to the salt spray test specified in ASTM B 117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D 520, Type I.

2.08 FIELD APPLIED INSULATION

A. Field applied insulation shall be provided and installed in accordance with Section 15250 MECHANICAL INSULATION.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not

be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

B. Directional Changes - Changes in direction shall be made with fittings, except that bending of pipe 4 inches and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

C. Functional Requirements - Piping shall be installed 1/2 inch per 10 feet of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the Contract Drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

D. Fittings and End Connections

1. Threaded Connections - Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D 3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

2. Brazed Connections - Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using

nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

3. Flared Connections - When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

E. Valves

1. General - Refrigerant stop valves shall be installed on each side of each piece of heat pump equipment such as compressors, condensers, evaporators, etc, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated noncondensible gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

2. Expansion Valves - Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2-1/8 inches in diameter and at the 4 o'clock or 8 o'clock position on lines larger than2-1/8 inches. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

F. Strainers - Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

G. Filter Dryer - A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

H. Sight Glass - A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

I. Discharge Line Oil Separator - Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

J. Flexible Pipe Connectors - Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

K. Temperature Gauges - Temperature gauges shall be located specifically on, but not limited to the following: the liquid line leaving a receiver and the suction line at each evaporator. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

L. Pipe Hangers, Inserts, and Supports - Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

1. Hangers - Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

2. C-Clamps - Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3. Angle Attachments - Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

4. Saddles and Shields - Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, Type 40 shields shall be used on all piping less than 4 inches. A high

density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

5. Horizontal Pipe Supports - Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves.

6. Vertical Pipe Supports - Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet mfrom end of risers, and at vent terminations.

7. Structural Attachments - Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided.

8. Building Surface Penetrations - Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A 653/A 653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A 53/A 53M, Schedule 30. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

    a. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed.

b. Field Applied Insulation - Field installed insulation shall be as specified in Section 15250 MECHANICAL INSULATION, except as defined differently herein.

c. Field Painting - Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory are specified in Division 9 Painting section.

3.02 CLEANING AND ADJUSTING

A. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Owner. Water shall not be used in any procedure or test.

3.03 REFRIGERANT PIPING TESTS FOR FIELD-FABRICATED PIPING

A. After all components of the refrigerant system have been installed and connected, the entire refrigeration system shall be subjected to pneumatic, evacuation, and startup tests as described herein. Tests shall be conducted in the presence of the Engineer unless approval is given otherwise. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor. The services of a qualified technician shall be provided as required to perform all tests and procedures indicated herein.

B. Preliminary Procedures - Prior to pneumatic testing, equipment which has been factory tested and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

C. Pneumatic Test - Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus 55 degrees C (minus 70 degree F) dewpoint and less than 5

ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ASHRAE 15 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24 hour period, the system pressure shall be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree C change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

D. Evacuation Test - Following satisfactory completion of the pneumatic tests, the pressure shall be relieved and the entire system shall be evacuated to an absolute pressure of 300 micrometers. During evacuation of the system, the ambient temperature shall be higher than 2 degrees C (35 degrees F). No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed and the system shall stand for 1 hour. If the pressure rises over 500 micrometers after the 1 hour period, then the system shall be evacuated again down to 300 micrometers and let set for another 1 hour period. The system shall not be charged until a vacuum of at least 500 micrometers is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

E. System Charging and Startup Test - Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The

entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

F. Refrigerant Leakage - If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

G. Contractor's Responsibility - The Contractor shall, at all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Owner including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

END OF SECTION

SECTION 15190

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes mechanical identification materials and devices.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for identification materials and devices.

1.04 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices after completion of covering and painting where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 IDENTIFYING DEVICES AND LABELS

A. General: Products specified are manufacturer's standard products of categories and types required for each application as referenced in other Division 15 Sections. Where more than single type is specified for listed

application, selection is Installer's option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate permanently fastened to equipment and having data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.

2. Location: An accessible and visible location.

C. Pressure-Sensitive Pipe Markers: Manufacturer's standard pre-printed, color-coded, pressure-sensitive vinyl pipe markers, with permanent adhesive conforming to ASME A13.1.

D. Pipes Smaller Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

E. Lettering: Use piping system terms as indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

F. Plastic Equipment Markers (Heat Pumps, Air Handlers, Etc): Laminated-plastic, in the following color code:

1. Green: Cooling equipment and components.

2. Terminology: Include following, matching schedules as closely as possible:

a. Name and plan number.
b. Equipment service.
c. Design capacity
d. Other design parameters such as pressure drop, entering and leaving conditions.

3. Size: Approximate 2-1/2 by 4 inches for control devices, dampers, and valves; and 4-1/2 by 6 inches for equipment.

G. Plasticized Tags: Pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing.

1. Size: Approximately 3-1/4 by 5-5/8 inches.

2. Fasteners: Brass grommets and wire.

3. Nomenclature: Large-size primary wording such as "DANGER," "CAUTION," or "DO NOT OPERATE."

H. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated on the Drawings. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

PART 3 - EXECUTION

3.01 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Locate pipe markers and color bands as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

a. Near each valve and control device.

b. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.

c. Near penetrations through walls, floors, ceilings, or enter non-accessible enclosures.

d. Near major equipment items and other points of origination and termination.

e. Spaced at a maximum of 25-feet intervals along each run.

f. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

B. Equipment Labeling

1. Provide equipment labels on all mechanical equipment that is individually tagged on the Drawings.

2. Provide equipment labels on all equipment with electrical service regardless of whether or not the equipment is tagged on the Drawings. The equipment label shall bear the same name as the circuit breaker label that serves the equipment. This labeling requirement applies to all equipment on the project regardless of what Division it is furnished under.

END OF SECTION

SECTION 15250

MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes all pipe, duct, electric heat tape and equipment insulation.

B. Aluminum jacketing is required on all fiberglass pipe and duct insulation, except as noted herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

B. Related Sections: The following sections contain requirements that relate to this section:

1. Section 15145 "Hangers and Supports" for pipe insulation shields and protection saddles.

2. Section 15810 "HVAC Ductwork" for duct lining.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Section 15010 General HVAC Requirements, Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of mechanical insulation identifying k-value, thickness, and accessories.

2. Identify insulation thickness and type used for each size of pipe duct or piece of equipment.

3. Provide installation details of field-applied jackets.

1.04 QUALITY ASSURANCE

A. Installer's Qualifications: The installer shall be an insulating contractor who has complete five projects of similar scale and complexity within the last three years.

B. Fire Performance Characteristics: Conform to the following characteristics for insulation including facings, cements, and adhesives, when tested according to ASTM E 84, by UL or other testing or inspecting organization acceptable to the authority having jurisdiction. Label insulation with appropriate markings of testing laboratory.

1. Interior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

2. Exterior Insulation: Flame spread rating of 25 or less and a smoke developed rating of 50 or less.

1.05 DEFINITIONS

A. Hot Surfaces: Normal operating temperatures of 100 deg F or higher.

B. Dual-Temperature Surfaces: Normal operating temperatures that vary from hot to cold.

C. Cold Surfaces: Normal operating temperatures less than 75 deg F.

D. Thermal Resistivity: "r-values" represent the reciprocal of thermal conductivity (k-value). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between two exposed faces required to cause one Btu to flow through one square foot of material, in one hour, at a given mean temperature.

E. Density: Is expressed in lb/cubic ft.

1.06 SEQUENCING AND SCHEDULING

A. Schedule insulation application after testing of piping and duct systems are tested and completed.

1.07 DELIVERY AND STORAGE OF MATERIALS

A. Deliver all materials to the job site and protect the insulation against dirt, water, chemical and mechanical damage before, during and after installation. Do not install damaged insulation and remove it from the job site.

B. Deliver insulation, coverings, cements, adhesives coatings etc. to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products, name of manufacturer and brand.

C. Installed insulation which has not been weatherproofed shall be protected from inclement weather by an approved waterproof sheeting installed by the Contractor. Any water-damaged insulation shall be removed and replaced by the Contractor at no additional cost.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Glass Fiber: - Use for all HVAC piping, duct and Plumbing systems.

    a. CertainTeed Corporation
    b. Knauf Fiberglass GmbH
    c. Manville.
    d. Owens-Corning Fiberglas Corporation
    e. Or equal

2. Flexible Elastomeric Cellular – Equipment and Condensate only

    a. Armstrong World Industries, Inc.
    b. Halstead Industrial Products
    c. IMCOA.
    d. Rubatex Corporation
    e. Or equal

3. Heat Tracing Systems.

    a. Chromalox.
    b. Raychem
    c. Or equal.

2.02 PIPE INSULATIONS

A. Glass Fiber: ASTM C 547, Type I; rigid molded, noncombustible.

1. ‘K’ (‘ksi’) Value: 0.23 at 75 F Mean Temperature (0.033 at 24 C).

2. Maximum Service Temperature: 0 F to 850 F (-18 C to 454 C).

3. Vapor Retarder Jacket: AP-T PLUS White kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self sealing longitudinal laps and butt strips or AP Jacket.

B. Elastomeric Foam: ASTM C 534, Type I; flexible, cellular elastomeric, molded.

1. 'K' ('ksi') Value: 0.30 at 75°F Mean Temperature (0.04 at 24°C).

2. Maximum Service Temperature of 150°F .

3. Maximum Flame Spread: 25*.

4. Maximum Smoke Developed: 50*.

5. Connection: Waterproof vapor retarder adhesive as needed.

6. UV-Protection: Outdoor protective coating.

* Max 3/4” to achieve 25/50 rating.

C. Field Applied Jackets (See Part 3 for Application):

1. Canvas Jacket (Mechanical room only): UL listed fabric, 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

2. Aluminum Jacket: 0.016 inch (0.045 mm) thick sheet, (smooth / embossed) finish, with longitudinal slip joints and 2 inch (50 mm) laps, die shaped fitting covers with factory applied moisture barrier.

2.03 DUCTWORK INSULATION

A. Flexible Fiber Glass Blanket: Manville Microlite Type 75, ¾ lb. Knauf Duct Wrap, or Equal, meeting ASTM C 1290 Type III, flexible blanket.

1. 'K' ('ksi') Value : 0.27 at 75°F Mean Temperature (0.040 at 24°) is

the minimum requirement. The total insulation R-value, however, must comply with the insulation schedule in Part 3 of this Section.

2. Operating Service Temperature Limits: 40°F to 250°F (4°C to 121°C).

3. Density: .75 lb/cu ft (12 kg/cu m).

4. Vapor Barrier Jacket: FSK, Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Rigid Fiber Glass Board: Manville 814 Spin-Glas, 3 lb. Knauf insulation board, or equal, meeting ASTM C 612, Type 1A & IB; rigid board

1. 'K' ('ksi') Value : 0.23 at 75°F Mean Temperature (0.033 at 24°C).

2. Operating Temperature Limits:
   0°F to 450°F (-18°C to 232°C) AP Jacket
   40°F to 450°F (4°C to 121°C) FSK Jacket

3. Density: 3.0 lb/cu ft (48 kg/cu m).

4. Vapor Retardant Jacket: AP, bleached kraft paper bonded to aluminum foil, reinforced with fiber glass yarn; or FSK, Aluminum foil reinforced with fiber glass yarn and laminated to fire-resistant kraft shall be secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

5. The use of weld pins that leave a sharp protruding edge is not acceptable. It is also not acceptable to utilize plastic caps in an attempt to mitigate the danger of these types of weld pins. Where weld pins are necessary, the type with large round washer with no sharp edges or points shall be utilized.

C. Canvas Jacket (Mechanical room only): UL listed fabric, 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.

2.04 SELF REGULATING HEATING CABLES

A. Summary: Extent of electric heating cable work is indicated by Drawings and as specified herein. Refer to Division 16 sections for wires/cables

raceways, boxes and fittings, which are required in conjunction with electric heating cables, not work of this section.

B. Quality Assurance:

1. Manufacturer's Qualifications: Firms regularly engaged in manufacture of electric heating cables, of types, sizes and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC as applicable to construction and installation of electric heating cables.

3. UL Compliance: Comply with applicable torquing requirements of UL Standard 486A; "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide electric heating cables and components which are UL listed and labeled.

4. IEEE Compliance: Comply with applicable recommended installation practices of IEEE Std. 241, "Recommended Practice for Electric Power Systems in Commercial Buildings", pertaining to electric heating cables.

5. NEMA Compliance: Provide electric heating cables and accessories which comply with NEMA standard.

C. Delivery, Storage and Handling: Deliver electric heating cables in factory-fabricated type containers or wrappings, which properly protect cables from damage.

Store electric heating cables in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

Handle electric heating cables carefully to prevent physical damage to cables and components. Do not install damaged cables; remove from site and replace damaged cables with new.

D. Electric Heating Cables:

Provide self-regulating heat-tracing electric heating cable and components which are suitable for freeze protection of metal or plastic piping. Select heater consisting of 2-16 AWG tinned-copper bus wires

paralles embedded in a radiation cross-linked conductive polymer core that varies its power output to respond to temperature along its length, allowing the heater to be crossed over itself without overheating, to be cut to length in the field, and to be used directly on plastic pipe. Cover heater with a radiation cross-linked modified polyolefindielectric jacket. Provide heater with a self-regulating factor of greater than 90% to conserve energy and to prevent overheating. Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output ranging from 40□ F (4□ C) pipe temperature operation to 150□ F (65□ C) pipe temperature operation. Cables must be UL listed for the application in which they are being installed.

E. Provide heating system accessories including, but not limited to, tapes, cables ties, warning labels, end seals and splices, thermostats, power connection cord, and installation clips for the application indicated and for a complete system.

F. Cables for use with pipe sizes up to 1” shall be 3 watt per foot Chromalox SRL3, or equal. Cables for use with pipe sizes 1 1/2” to 4” shall be 5 watts per foot Chromalox SRL5, or equal.

G. Provide where indicated on the drawings at each power connection point, a Chromalox RTSR, or equal, power connection box with ambiet sensing thermostat. All connections shall be for 120v, single phase.

PART 3 - EXECUTION

3.01 PREPARATION

A. Surface Preparation: Clean, dry, and remove foreign materials such as rust, scale, and dirt.

B. Mix insulating cements with clean potable water. Mix insulating cements contacting stainless-steel surfaces with demineralized water.
   1. Follow cement manufacturer's printed instructions for mixing and portions.

3.02 INSTALLATION, GENERAL

A. Refer to schedules at the end of this Section for materials, jackets, and thicknesses required for each mechanical system.

B. Select accessories compatible with materials suitable for the service. Select accessories that do not corrode, soften, or otherwise attack the insulation or jacket in either the wet or dry state.

C. Install vapor barriers on insulated pipes, ducts, and equipment having surface operating temperatures below 60 deg F.

D. Apply insulation material, accessories, and finishes according to the manufacturer's printed instructions.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

K. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Factory-insulated flexible ducts.

2. Factory-insulated plenums.

3. Flexible connectors for ducts and pipes.

4. Vibration control devices.

5. Testing laboratory labels and stamps.

6. Nameplates and data plates.

7. Access panels and doors in air distribution systems.

8. Sanitary drainage and vent piping.

9. Drainage piping located in crawl spaces, unless indicated otherwise.

10. Below grade piping.

11. Chrome-plated pipes and fittings.

12. Piping specialties including plug valves and flow regulators.

3.03 FIBERGLASS PIPE INSULATION INSTALLATION

A. Tightly butt longitudinal seams and end joints. Securely place butt strips around butt joint.

B. Stagger joints on double layers of insulation.

C. Apply insulation continuously over fittings, valves, and specialties, except as otherwise indicated.

D. Apply insulation with a minimum number of joints.

E. Exterior Wall Penetrations: For penetrations of above grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor barrier coating.

F. Exterior Wall Penetrations: For penetrations of below grade exterior walls, extend metal jacket for exterior insulation through penetration to a point 2 inches from interior surface of wall inside the building. Seal ends of metal jacket with vapor barrier coating. Secure metal jacket ends with metal band. At point where insulation metal jacket contacts mechanical sleeve seal, insert cellular glass preformed pipe insulation to allow sleeve seal tightening against metal jacket. Tighten and seal sleeve to jacket to form a watertight seal.

G. Interior Walls and Partitions Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions. Apply an aluminum jacket with factory-applied moisture barrier over insulation. Extend 2 inches from both surfaces of wall or partition. Secure aluminum jacket with metal bands at both ends. Seal ends of jacket with vapor barrier coating. Seal around penetration with joint sealer.

H. Floor Penetrations: Terminate insulation underside of floor assembly and at floor support at top of floor.

I. Flanges, Fittings, and Valves - Interior Exposed and Concealed: Coat pipe insulation ends with vapor retardant coating. Apply premolded, precut, or field-fabricated segments of insulation around flanges, unions, valves, and fittings. Make joints tight. Bond with adhesive.

1. Use same material and thickness as adjacent pipe insulation.

2. Overlap nesting insulation by 2 inches or 1-pipe diameter, which ever is greater.

3. Apply materials with adhesive, fill voids with mineral fiber insulating cement. Secure with wire or tape.

4. Insulate elbows and tees smaller than 3-inches pipe size with premolded insulation.

5. Insulate elbows and tees 3 inches and larger with premolded insulation or insulation material segments. Use at least 3 segments for each elbow.

6. Cover insulation, except for metal jacketed insulation, with PVC fitting covers and seal circumferential joints with butt strips.

7. Cover insulation, except for metal jacketed insulation, with 2 layers of lagging adhesive to a minimum thickness of 1/16 inch. Install glass cloth between layers. Overlap adjacent insulation by 2 inches in both directions from joint with glass cloth and lagging adhesive.

J. Hangers and Anchors: Apply insulation continuously through hangers and around anchor attachments. For cold surface piping, extend insulation on anchor legs a minimum of 12 inches and taper and seal insulation ends.

K. Provide insert between support shield and piping on piping 1 ½ inches (38 mm) diameter or larger. Fabricate of Thermo-12 or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths;

1 ½” to 2 ½” pipe size	10” long
3” to 6” pipe size	12” long

L. All fiberglass piping insulation shall be protected with an aluminum jacket.

3.04 FLEXIBLE ELASTOMERIC CELLULAR PIPE INSULATION INSTALLATION – CONDENSATE DRAIN ONLY

A. Slip insulation on the pipe before making connections wherever possible. Seal joints with adhesive. Where the slip-on technique is not possible, cut

one side longitudinally and apply to the pipe. Seal seams and joints with adhesive. Loose insulation and visible pipe will be grounds for rejection of system.

B. Valves, Fittings, and Flanges: Cut insulation segments from pipe or sheet insulation. Bond to valve, fitting, and flange and seal joints with adhesive.

1. Miter cut materials to cover soldered elbows and tees.

2. Fabricate sleeve fitting covers from flexible elastomeric cellular insulation for screwed valves, fittings, and specialties. Miter cut materials. Overlap adjoining pipe insulation.

3.05 FINISHES

A. Aluminum jacketing shall NOT be field-painted.

B. Flexible Elastomeric Cellular Insulation: After adhesive has fully cured, apply 2 coats of protective coating to exposed insulation. See Division 9 Painting.

3.06 DUCT INSULATION

A. Ductwork External Insulation:

1. Seal all vapor retardant jacket seams and penetrations with UL listed tapes or vapor retardant adhesive.

2. Continue insulation through walls, sleeves, hangers, and other duct penetrations except where prohibited by code.

3. All ductwork insulation on this project shall be finished with aluminum jacket, except where located above a tile ceiling or where located inside a mechanical room. Canvas jacketing may be utilized in lieu of aluminum for insulation protection inside mechanical rooms. Jacketing is not required above tile ceilings.

3.07 APPLICATIONS

A. General: Materials and thicknesses are specified in following paragraph in schedules at the end of this Section.

B. Interior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

2. Domestic hot water.

3. Recirculated hot water.

4. All interior supply and return refrigerant/heat pump piping, valves, and specialties.

C. Interior, Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

2. Domestic hot water.

3. Recirculated hot water.

4. All interior refrigerant/heat pump piping, valves, and specialties.

D. Exterior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:

1. Domestic cold water.

2. Refrigerant pipes/tubes.

E. Equipment: Unless otherwise indicated, insulate the following indoor equipment:

1. Domestic cold water equipment, tanks, and pumps.

2. Domestic hot water equipment, tanks, and water heaters. (not required if internally insulated)

F. Duct Systems: Unless otherwise indicated, insulate the following duct systems:

1. Interior concealed supply and outside air ductwork.

2. Interior exposed supply and outside air ductwork.

3. Exhaust Ductwork – last 10’ prior to exhaust fan.

G. Items Not Insulated: Unless otherwise indicated do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors for ducts and pipes.

2. Vibration control devices.

3. Testing laboratory labels and stamps.

4. Nameplates and data plates.

5. Sanitary drainage and vent piping.

6. Drainage piping located in crawl spaces, unless indicated otherwise.

7. Below grade piping.

8. Chrome-plated pipes and fittings.

3.08 HEAT TAPE INSTALLATION

A. Examination: Examine areas and conditions under which electric heating cables are to be installed and notify Contractor in writing of conditions detrimental to proper completion of the work. Ensure that surfaces, and pipes to which electric heating cables are to be installed are free of burrs and sharp protrusions and that pipes have been pressure tested for leakage. Also ensure that surfaces and substrates where cables are installed are plumb and level. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to Installer.

B. Installation of Electric Heating Cables: Install electric heating cables including components as indicated, in accordance with equipment manufacturer's written instructions, applicable portions of NEC, and with recognized industry practices to ensure that units fulfill requirements. Comply with applicable installation requirements of NECA's "Standard of Installation."

Coordinate with other work including concrete, finish work, and electrical work as necessary to interface installation of electric heating cables with other work.

Protect installed electric heating cables, including leads, from damage and crushing by construction work.

Connect electrical power, fasten end-seals, and accomplish splicing of electric heating cables properly in accordance with requirements.

Tighten electrical connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A and B.

C. Grounding: Provide equipment grounding connections for electric heating cables as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

D. Field Quality Control: Prior to energizing electrical power circuitry, test installed electric heating cabling, including splice and tee connections, for electrical continuity. After attaching electric heating cables to pipe, test cables for continuity and insulation resistance of 10 megohms, or greater, measured to ground. Where leakage detected, remove cabling and replace with new and proceed with retesting to demonstrate compliance.

E. Install insulation with smooth, straight, and even surfaces.

F. Seal joints and seams to maintain vapor barrier on insulation requiring a vapor barrier.

G. Seal penetrations for hangers, supports, anchors, and other projections in insulation requiring a vapor barrier.

H. Seal Ends: Except for flexible elastomeric insulation, taper ends at 45 degree angle and seal with lagging adhesive. Cut ends of flexible elastomeric cellular insulation square and seal with adhesive.

I. Apply adhesives and coatings at manufacturer's recommended coverage-per-gallon rate.

J. Keep insulation materials dry during application and finishing.

3.09 PIPING INSULATION SCHEDULE

A. Fiberglass Insulation

PIPE SIZES:	1-1/2" and below	2" and above
Refrigeration Lines	1.0	1.0
Domestic Cold & Hot Water	1.0	1.0
Plumbing Vents within 10' of Exterior	1.0	1.0
Piping Exposed to Freezing	1.5	1.5

B. ELASTOMERIC FOAM

Condensate Piping Only	all sizes	0.75”

3.10 DUCTWORK INSULATION SCHEDULE

	Minimum R Value	FINISH
A. Flexible Fiber Glass		
Exhaust Ducts Within 10 ft (3 m) of Exterior Openings	5	FSK
Air Ventilation Equipment Casings	5	
Supply Ducts (Cooling Systems)	5	FSK
Outside Air Ducts	8	FSK
B. Rigid Fiber Glass		
Plenums (Cooling Systems)	8	FSK

END OF SECTION

SECTION 15728

SPLIT AIR-COOLED HEAT PUMP SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide new heat pump systems as indicated on Drawings and as herein specified. Contractor must include all accessories noted in the schedules as well as all equipment requirements noted herein for each piece of equipment.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division0 and 1 Specification Sections, apply to Work of this Section.

B. Refer to Section 15010 - HVAC General Requirements for additional work of this Section.

C. Section 15182 – Refrigerant Piping

1.03 QUALITY ASSURANCE

A. Single Source Responsibility: All major air handling equipment shall be of the same manufacturer.

B. Coordination of Work: The installation of the new units shall be coordinated with all trades to ensure they will fit into spaces prior to walls, ceilings, and other structural items are installed.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's technical information including wiring diagrams clearly identifying all field connections, and installation instructions for each unit furnished.

B. Submit with each unit the following; coil selections, fan curves, fan sound power ratings, material gauges, and other performance data with the entering water, refrigerant, and air conditions noted in the schedules on the drawings.

C. Clearly list and identify each accessory and spare part to be furnished under this contract.

D. Shop Drawings shall be submitted that detail equipment assemblies and indicated dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1.05 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. O & M Manuals shall be available to the Owner prior to equipment training commences.

D. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

E. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies.

1.06 DELIVERY AND STORAGE

A. Deliver units as a factory-assembled module with protective crating and covering.

B. Lift and support units with manufacturer’s designated lifting and supporting points.

1.07 SEQUENCING AND SCHEDULING

A. Coordinate size and location of concrete housekeeping bases.

B. Coordinate size and location of structural-steel support members.

1.08 SPARE PARTS

A. Furnish one set of extra filters for each air-handling unit.

B. Furnish one set of extra fan belts for each belt driven fan.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:

1. Trane Company
2. Carrier Corporation
3. York International
4. McQuay
5. Or equal

2.02 HEAT PUMP UNITS

A. The unit shall be fully charged from the factory for up to 15 feet of piping. The unit shall be designed to operate at outdoor ambient temperatures as high as 115°F. Cooling capacities shall be matched with a wide selection of air handlers and furnace coils that are A.R.I. certified. The units shall be UL listed. Exterior shall be designed for outdoor application. Refrigerant shall be Puron R-410a.

B. Casing – Unit casing shall be constructed of heavy gauge, galvanized steel and painted with a weather-resistant powder paint. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500--hr salt spray test.

C. Refrigerant Controls: Refrigeration system controls shall include condenser fan and compressor contactor. High and low pressure controls inherent to the compressor. A factory installed liquid line drier shall be standard.

D. The compressor shall feature a 5 year limited warranty, internal over temperature and pressure protection, and vibration isolation. Shall have low vibration and noise. Compressor shall be variable speed with 5 stages of operation yielding capacity turndown to 25%.

E. Condenser Coil: The outdoor coil shall provide low airflow resistance and efficient heat transfer. The coil shall be protected on all four sides by louvered panels and shall have a 5 year limited warranty.

F. Low Ambient Cooling: The unit shall be equipped with low ambient cooling provisions to allow operation at an ambient temperature down to 40◦F.

G. Thermostats: Provide heat/cooling with autochangeover functionality and digital display. Thermostat shall accommodate multiple stages of operation and variable fan speed.

H. Provide support feet for unit to raise it a minimum of 8” above pad.

I. Electrical system shall have single point power connection with control transformer and all necessary controls included, and shall be compliant with IEC 61000--4--5 Transient Surge Requirement.

2.03 FAN COIL AIR HANDLING UNITS

A. Chassis: Galvanized steel with flanged edges.

B. Coil Section Insulation: Faced, heavy-density, glass-fiber insulation over entire section.

C. Drain Pans: glass-filled polycarbonate resin, with brass connection for drain.

D. Cabinet: Galvanized steel with removable insulated panels. Air leakage shall be 1.4% or less at 0.5” w.c. per Ashrae 193.

E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer.

F. Fin-and-Tube Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm). Leak test to 300 psig (2068 kPa) underwater. Provide factory-installed TXV.

G. Electric Heating Elements: Nickle-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium-oxide insulating refractory and sealed in high-mass steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch (4 mm). Element ends are enclosed in terminal box. Fin surface temperature shall not exceed 550□ F (288□ C) at any point during normal operation.

H. Electrical and Circuit Protection: Circuit breaker or breakers for overcurrent protection and limit controls for over temperature protection of heaters. Provide a control transformer and all electrical components for a complete system.

I. Centrifugal fan, with forward-curved, double-width wheels of reinforced fiberglass, in galvanized steel fan scrolls, directly connected to an electronically commutated (ECM) variable-speed motor.

J. Filters: 1-inch (25-mm) thick, throwaway filters in fiberboard frames.

PART 3- EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of equipment air-handling.

B. Examine roughing-in of condensate drainage piping, and electrical to verify actual locations of connections before installation.

C. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install units level and plumb, according to manufacturer's written instructions.

1. Floor-Mounted Units: Support on concrete housekeeping bases using neoprene pads. Secure units to anchor bolts installed in concrete housekeeping base.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance. Avoid conflicts with structural elements, piping, etc., with access doors.

3.03 HOUSEKEEPING BASES-FLOOR MOUNTED EQUIPMENT

A. Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches (100 mm) larger in both directions than overall dimensions of supported unit.

B. Form concrete bases with steel channels conforming to ASTM A 36 (ASTM A 36M), size and location as indicated. Miter and weld corner and provide cross bracing. Anchor or key to floor slab.

C. Form concrete bases with framing lumber with form-release compounds. Chamfer top edge and corners of base.

3.04 CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to machine to allow service and maintenance.

2. Connect condensate drain pans using 3/4-inch NPS (DN32) piping. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3. Refrigerant Piping: Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

B. Duct installation and connection requirements are specified in other Division 15 Sections. The Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

C. Electrical: Conform to applicable requirements of Division 16 Sections.

1. Connect fan motors to wiring systems and to ground. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.06 COMMISSIONING

A. Final Checks before Startup: Perform the following before startup:

1. Verify that unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete.

2. Perform cleaning and adjusting specified in this Section.

3. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

4. Install clean filters.

END OF SECTION

SECTION 15729

PORTABLE DEHUMIDIFICATION UNITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide new portable dehumidification units as indicated on Drawings and as herein specified.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division0 and 1 Specification Sections, apply to Work of this Section.

B. Refer to Section 15010 - HVAC General Requirements for additional work of this Section.

1.03 QUALITY ASSURANCE

A. Equipment shall be UL or ETL listed.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's technical information including wiring diagrams clearly identifying all field connections, and installation instructions for each unit furnished.

B. Shop Drawings shall be submitted that detail equipment assemblies and indicated dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1.05 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. O & M Manuals shall be available to the Owner prior to equipment training commences.

D. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

E. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies.

1.06 DELIVERY AND STORAGE

A. Deliver units as a factory-assembled module with protective crating and covering.

B. Lift and support units with manufacturer's designated lifting and supporting points.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:

1. Quest Hi-E Dry 195 or equal

2.02 PORTABLE DEHUMIDIFIER

A. The unit shall operate from a 120VAC single phase 20A circuit. Power usage shall be no more than 1500W at 80°F/60% RH conditions. A minimum 6-foot power cord is required.

B. Unit controls shall include a dehumidistat adjustable from 20% to 80% RH with positive "On" and "Off" settings.

C. Water removal shall be 195 pints minimum at 80°F/60% RH conditions.

D. Operating range shall be from 40 to 110°F.

E. Unit shall include a blower with approximately 610 cfm capacity.

F. Filters shall be MERV 11 pleated media.

G. Unit shall be mounted on casters for portability.

H. Internal condensate drain pan, connections, and condensate pump shall be included.

I. Warranty shall be 5 years on parts, 1 year on labor.

2.03 SPARE PARTS

A. Provide (1) extra filter for each dehumidifier.

PART 3- EXECUTION

3.01 INSTALLATION

A. Install units level and plumb, according to manufacturer's written instructions.

B. Arrange installation of units to provide access space around units for service and maintenance.

C. Provide ¾" condensate drain piping sloped ¼" per foot. Provide trap if necessary per mfr instructions.

3.02 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

3.03 COMMISSIONING

A. Final Checks before Startup: Perform the following before startup:

1. Verify that connections for piping and electrical are complete.

2. Perform cleaning and adjusting specified in this Section.

3. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

4. Install clean filters.

END OF SECTION

SECTION 15760

UNIT HEATERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and services required to furnish and install the unit heaters as indicted on the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical Requirements: Division 16

B. Basic Mechanical Requirements: Section 15010

C. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification sections, apply to work of this section.

1.03 SUBMITTALS

A. Submit manufacturer's technical product data, assembly-type shop drawings, ladder-type wiring diagrams differentiating between portions of wiring that are factory- installed and portions to be field-installed, and maintenance data.

B. Comply with the requirements of General Requirements and Special Conditions of these specifications.

1.04 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

D. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies.

1.05 QUALITY ASSURANCE

A. UL Compliance: Provide electrical components of terminal units which have been listed and labeled by UL.

B. Comply with NFPA 70 for components and installation.

PART 2 - PRODUCTS

2.01 ELECTRIC UNIT HEATERS

A. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

B. Horizontal Unit Heaters: Construct casings of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18-ga steel. Fabricate casing to enclose coil, louvers, and fan blades. Provide louvers for 4-way air diffusion. Construct fans of aluminum, and factory-balance. Provide fan inlet orifice, smooth, and drawn into casing back panel.

C. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

D. Electrical disconnect and thermostat is required.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install unit heaters as indicated, and in accordance with manufacturer's installation instructions. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated. Support units with rod-type hangers anchored to building substrate. Install piping as indicated. Protect units with protective covers during balance of construction.

3.02 ADJUSTMENT AND CLEANING OF TERMINAL UNITS

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

SECTION 15810

HVAC DUCTWORK

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes rectangular and round metal ducts for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.

B. Contractor shall provide all necessary duct transitions to air handling equipment openings whether indicated or not on the Drawings.

C. A ductwork/sheet metal Contractor shall perform the work specified herein. See Quality Assurance paragraph below for requirements.

D. Absolutely no fiberglass ductboard is allowed for this project. Any mention of fiberglass through the specifications refers to resin fiberglass plastic duct for corrosion prone areas.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 15 Sections apply to this section:

1. Section 15250 "Mechanical Insulation" for duct and plenum insulation.

2. Section 15820 "Duct Accessories" for flexible duct materials, dampers, duct-mounted access panels and doors, and turning vanes.

3. Section 15855 "Air Grilles, Registers, and Diffusers”.

4. Section 15010 “General HVAC Requirements”.

1.03 SUBMITTALS

A. Submit product data for duct material and sealing materials, dampers, etc.

B. Submit shop drawings from duct fabrication shop detailing:

1. Fittings.

2. Reinforcing details and spacing.

3. Seam and joint construction details.

4. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

5. Materials and gauge of duct material for each size used.

C. Submit red-lined record drawings indicating any field changes.

1.04 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

B. SMACNA Compliance:

1. HVAC Duct Construction Standards, Metal and Flexible. Comply with latest version

C. Sheet Metal Fabricators Qualifications:

1. The Sheet Metal Fabricator shall be a firm that specializes in duct construction and design. The duct layout shall be coordinated with structural, architectural, electrical and mechanical trades. The sheet metal shop shall utilize latest technology manufacturing equipment, computerized tracking and control methods, and be a member in good standing of SMACNA – Sheet Metal and Air Conditioning Contractors National Association.

1.05 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be accepted by the Engineer.

1.06 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

2. Joints: Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

PART 2 - PRODUCTS

2.01 SHEET METAL MATERIALS

A. Duct liner is not required on this project.

B. Sheet Metal, General: Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700 and SMACNA HVAC Duct Construction Standards.

C. Galvanized Sheet Steel: Shall be Lock-forming quality, ASTM A 527, Coating Designation G 90. All exposed sheet steel that is not insulated (e.g. return ducts) is required to be painted per Division 9 requirements. Note there are certain exceptions listed on the Drawings where aluminum or FRP duct is required for chemical corrosion protection.

2.02 SEALING MATERIALS

A. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids. Cault type sealant shall be UL listed fire resistive and be compatible with duct materials to be sealed. Sealant shall be United McGill's United Duct sealer, hardcast's Iron Grip, or Uni-Weather duct sealer, or equal.

B. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.03 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.

B. Hangers: Stainless steel, threaded rod.
   1. Rod Sizes: Conform with Table 4-1 in SMACNA HVAC Duct Construction Standards, 1985 Edition, for stainless steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Galvanized steel shapes conforming to ASTM A 36. Any exposed galvanized steel must be painted, or otherwise stainless steel is required.

2.04 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," Tables 1-3 through 1-19, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

   1. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

   2. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

   1. Supply Ducts: 2 inches water gauge.

   2. Return Ducts: 1 inches water gauge, negative pressure.

   3. Exhaust Ducts: 1 inches water gauge, negative pressure.

C. Cross breaking or Cross Beading: Cross break or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of un-braced panel area, as indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-4, unless they are lined or are externally insulated.

D. Turning Vanes: All turning vanes shall be of the double wall airfoil blade type.

2.05 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," Figures 2-1 through 2-10.

B. Refer to detail on the Drawings “Typical Diffuser and Branch Takeoff “ detail.

C. Elbows shall be square throat with airfoil double wall vanes. Single blade steel vanes are not acceptable. Curved backs are not a substitute for double wall vanes.

2.06 ROUND DUCT FABRICATION

A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct.

B. Round Ducts: Fabricate round supply ducts with spiral lockseam construction, except where diameters exceed 72 inches. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gauges.

C. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," Figure 3-1, RL-1, RL-4, or RL-5. Seams Types RL-2 or RL-3 may be used if spot-welded on 1-inch intervals. Comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gauges.

2.08 ROUND SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," Figures 3-4 and 3-5 and with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.

a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," Table 3-1.

b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

1) 3 to 26 inches: 24 gauge.
2) 27 to 36 inches: 22 gauge.
3) 37 to 50 inches: 20 gauge.
4) 52 to 60 inches: 18 gauge.
5) 62 to 84 inches: 16 gauge.

c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

1) 3 to 14 inches: 24 gauge.
2) 15 to 26 inches: 22 gauge.
3) 27 to 50 inches: 20 gauge.
4) 52 to 60 inches: 18 gauge.
5) 62 to 84 inches: 16 gauge.

2. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

3. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

4. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

5. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.

6. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.

7. Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.

8. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

2.09 FIBERGLASS REINFORCED PLASTIC

A. Ductwork, including fittings, shall be constructed of filament wound fiberglass reinforced plastic, as manufactured by Perry Fiberglass Products, Inc., or equal. The resin shall be Perry 20S Low Smoke, or equal.

B. The duct and fittings, as a finished composite, shall meet the Flame and Smoke requirements of a Class 1 duct per UL 181 and UMC 10-1. Liners and/or coatings are not acceptable. Performance shall have been verified by an ASTM E-84 testing laboratory recognized by the following building code organizations under the Council of American Building Officials: BOCA.

C. Wall thickness shall comply with PS 15-69 duct standards. The ductwork shall be furnished with the following minimum wall thickness 0.125" for ducts up to 20" in diameter, 0.187" for ducts 21" to 36" in diameter, and 0.25" for ducts 37" to 60" in diameter.

D. Rectangular Ductwork thickness shall be determined by substituting the long side for the round diameter.

E. Requirements of a Class 1 duct Per UL 181 and UMC 10-1

Flame Spread	-less than 25
Smoke	-less than 50
Development	-less than 10
Fuel Contributed	

PART 3 - EXECUTION

3.01 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Install ducts with the fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with minimum 1-inch clearance outside of insulation.

I. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

J. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and above electrical equipment spaces and enclosures.

K. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches. Seal around all floor penetrations to make water tight as to prevent water seepage around duct to floor below.

3.02 SEAM AND JOINT SEALING

A. Seal all transverse and longitudinal duct seams and joints.
NOTE: THIS EXCEEDS SMACNA STANDARDS!

B. Seal externally insulated ducts prior to insulation installation.

C. Duct sealant shall be water resistant, UL classified fire resistive, and be compatible with duct materials to be sealed. Sealant shall be United McGill's United Duct Sealer, Hardcast's Iron Grip, Uni-Weather duct sealer, or equal.

3.03 HANGING AND SUPPORTING

A. Install rigid round and rectangular metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-3 and Figures 4-1 through 4-8.

B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

C. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

D. Install concrete insert prior to placing concrete.

E. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 15 Section "Duct Accessories."
B. Branch Connections: Comply with detail on the drawings.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figures 2-16 through 2-18 and per detail on the drawings.

3.05 FIELD QUALITY CONTROL

A. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.06 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Division 15 Section "TESTING, ADJUSTING, AND BALANCING" for requirements and procedures for adjusting and balancing air systems.

B. All ducts must be sealed throughout construction to keep them clean. The Contractor shall vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION

SECTION 15820

DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:

1. Manual volume control dampers.

2. Turning vanes.

3. Duct-mounted access doors and panels.

4. Flexible connectors.

5. Flexible ducts.

6. Accessories hardware.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 15 Section "Air Grilles, Registers, and Diffusers".

2. Division 15 Section “HVAC Ductwork”.

1.03 SUBMITTALS

A. General: Submit all items in this Article in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Submit product data including details for materials, dimensions of individual components, profiles, and finishes for the following items:

1. Backdraft dampers

2. Manual volume control dampers.
3. Duct-mounted access panels and doors.

4. Flexible ducts.

5. Ductwork construction material.

1.04 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. SMACNA Compliance: All ductwork accessories shall be installed in accordance with latest edition of SMACNA HVAC Duct Construction Standards, Metal and Flexible

PART 2 - PRODUCTS

2.01 MANUAL VOLUME CONTROL DAMPERS

A. General: Provide factory-fabricated volume-control dampers, complete with required hardware and accessories. Stiffen damper blades to provide stability under operating conditions. Provide locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class. Extend axles full length of damper blades. Provide bearings at both ends of operating shaft.

2.02 TURNING VANES

A. Manufactured Turning Vanes: Fabricate of 1-1/2-inch-wide, airfoil double curved blades set at 3/4 inch on center, support with bars perpendicular to blades set at 2 inches on center, and set into side strips suitable for mounting in ducts.

B. Acoustic Turning Vanes: Fabricate of airfoil-shaped aluminum extrusions with perforated faces and fiber glass fill.

2.03 DUCT-MOUNTED ACCESS DOORS AND PANELS

A. General: Provide construction and airtightness suitable for duct pressure class.

B. Frame: Galvanized sheet steel. Provide with bend-over tabs and foam gaskets.

C. Door: Galvanized sheet metal construction thickness, number of hinges and locks as indicated for duct pressure class. Provide 1-inch by 1-inch butt hinge or piano hinge and cam latches.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber seals.

E. Install an access panel at heat pump AHU return duct plenum.

2.04 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL Standard 181, Class 1.

B. Standard Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

C. Extra-Wide Metal-Edged Connectors: Factory-fabricated with a strip of fabric 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

D. Transverse Metal-Edged Connectors: Factory-fabricated with a strip of fabric 3-1/2 inches wide attached to 2 strips of 4-3/8-inch-wide, 24-gage, galvanized sheet steel or 0.032-gage aluminum sheets. Select metal compatible with connected duct system. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA HVAC Duct Standard, 1st Edition, Figure 2-19.

E. Conventional, Indoor System Flexible Connectors Fabric: Glass fabric double coated with polychloroprene.

1. Minimum Weight: 26 oz. per sq yd.

2. Tensile Strength: 480 lb per inch in the warp and 360 lb per inch in the filling.

2.05 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1; NFPA 90A and 90B.

B. Flexible Ducts - Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-inch-thick, glass fiber insulation around a continuous inner liner. Insulation shall have a minimum working pressure of 6” w.g.

1. Reinforcement: Steel-wire helix encapsulated in the inner liner.

2. Outer Jacket: Polyethylene film.

3. Inner Liner: Polyethylene film.

4. Insulation; maximum C-Value of 0.23 BTU/hr/SF/deg. F at 75□ F mean temperature.

2.06 ACCESSORIES HARDWARE

A. Splitter Damper Accessories: Zinc-plated damper blade bracket, 1/4-inch, zinc-plated operating rod, and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.

B. Flexible Duct Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm-gear action. Provide in sizes from 3 to 18 inches to suit duct size.

C. Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of duct accessories. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install duct accessories according to manufacturer's installation instructions and applicable portions of details of construction as shown in SMACNA standards.

3.03 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual dampers is specified in Division 15 Section "Testing, Adjusting, and Balancing."

END OF SECTION

SECTION 15830

POWER VENTILATORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:

1. Ceiling-mounted ventilators.

2. Wall or Roof mounted centrifugal.

3. In-Line ventilators

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including rated capacities of each unit, weights (shipping, installed, and operating), furnished specialties, accessories, and the following:

1. Certified fan performance curves with system operating conditions indicated.

2. Certified fan sound power ratings.

3. Motor ratings and electrical characteristics plus motor and electrical accessories.

4. Material gauges and finishes, including color charts.

5. Dampers, including housings, linkages, and operators.

1.04 OPERATING AND MAINTENANCE MANUALS

A. Three sets of O&M instructions and manuals shall be submitted in loose-leaf 3-ring cardboard reinforced vinyl binders to the Engineer in accordance with the General Conditions.

B. Contained in each binder shall also be vendors, warranty information, vendor phone numbers, list of materials, and materials parts list.

C. O & M Manuals shall be available to the Owner prior to equipment training commences.

D. General and Supplemental General Conditions shall supercede this paragraph where conflicts occur.

E. O & M manuals shall be submitted on CD disk in PDF format along with the required paper copies.

1.05 QUALITY ASSURANCE

A. Electrical Component Standard: Provide components that comply with NFPA 70 and that are listed and labeled by UL where available.

1.06 PERFORMANCE REQUIREMENTS

A. Fan Unit Schedule: The following information is described in an equipment schedule on the Drawings.

1. Fan performance data including capacities, outlet velocities, static pressures, motor requirements, and electrical characteristics.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Ventilators:

a. Broan Mfg. Co., Inc.
b. Carnes Co.
c. Cook (Loren) Co.
d Greenheck Fan Corp.
e. ILG Industries, Inc.

f. Jenn Industries Inc.
g. Or Equal

2.02 CEILING-MOUNTED VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications. Unit shall have automatic backdraft damper, and be rated for continuous operation.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: White polymeric, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

2.02 CENTRIFUGAL WALL EXHAUST FANS

A. General Description:

1. Fan shall discharge air directly away from the mounting surface.

2. Shall have an operating temperature range of -20°F to 110°F with full sunlight exposure.

3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.

B. Wheel: Material type shall be aluminum, non-overloading, backward inclined centrifugal, statically and dynamically balanced in accordance to AMCA Standard 204-05. The wheel cone and fan inlet shall be matched and shall have precise running tolerances for maximum performance and operating efficiency

C. Motor: Enclosure shall be open driproof. Motor shall be permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase indicated on the Drawings. Shall be mounted on vibration isolators, out of the airstream. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants. Motor shall be accessible for maintenance with an aluminum cover.

D. Shaft and Bearings: Fan shaft shall be ground and polished solid steel with an anti-corrosive coating. Provide permanently sealed bearings or pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,00 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed. Bearing shall be 100 percent factory tested. Fan shaft first critical speed shall be at least 25 percent over maximum operating speed.

E. Housing: Shall be constructed of heavy gauge aluminum including exterior housing, windband, and motor compartment housing. Galvanized material is not acceptable. Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing. Windband to include an integral rolled bead for strength. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it. Finish shall be baked enamel unless noted otherwise. Provide color chart for Owner selection of color.

F. Disconnect Switch shall be wired for positive electrical shut-off and shall be installed within motor compartment.

G. Drive Assembly: Belts, pulleys, and keys shall be oversized for a minimum of 150 percent of driven horsepower. Belt shall be static free and oil resistant. Pulleys shall be cast type, keyed, and securely attached to wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing and readily accessible for maintenance.

2.03 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron, adjustable-pitch motor pulley.

4. Fan and motor isolated from exhaust air stream.

E. Accessories: The following are required for each ventilators:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2. Bird Screens: Removable ½-inch mesh, aluminum or brass wire.

G. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base

2.04 ROOF CURBS

A. Roof Curbs: G90 (or better) Galvanized Steel; mitered and welded corners; 2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in cant and mounting flange.

2. Overall Height: Minimum 12 inches above finished roof.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install power ventilators according to manufacturer's written instructions.

B. Support units using the vibration-control devices.

1. Ceiling Units: Suspend units from structure using stainless threaded rod.

C. Install units with clearances for service and maintenance.

D. All fasteners for fans, vents, etc. used outside shall be constructed on non-ferrous stainless steel.

E. Refer to Architectural Division 9 for curb and fan painting requirements.

END OF SECTION

SECTION 15850

LOUVERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and services required to furnish and install the louvers as shown on the Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical: Division 16

B. Painting and Finishes: Division 9.

C. Drawings and general provisions of Contract, including General and Supplementary Conditions and Divisions 0 and 1 Specification Sections, apply to this Section.

1.03 SUBMITTALS

A. Submit manufacturer's technical product data, assembly-type shop drawings, and maintenance data in conformance with General Conditions of these specifications.

1.04 QUALITY ASSURANCE

A. AMCA Compliance: Test and rate louvers and dampers in accordance with AMCA Standard 500, provide Certified Ratings Seal on each unit.

PART 2 - PRODUCTS

2.01 LOUVERS

A. Fabrication, General: Fabricate louvers and accessories to comply with requirements indicated for design (blade angle, blade profile, blade spacing), metal type and form, sizes, depth, arrangement, and metal thicknesses indicated or required for performance and use intended.

B. Structural Performance: Design, engineer, fabricate and install units capable of withstanding the effects of loads and stresses from wind and normal thermal movement without evidencing permanent deformation of

components, metal fatigue or noise from louver blade rattle or flutter, and permanent damage to fasteners or anchors.

1. Wind Load: Uniform pressure of 20 lb. per sq. ft., acting inwards and outwards.
2. Normal thermal movement from ambient temperature change (range) of 100 deg F and its effect on metal surfaces due to both solar heat and night time sky heat loss.

C. Preassemble units in shop.

D. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

American Warming and Ventilating Co.
Arrow United Industries
Greenheck Mfg. Co.
Ruskin Mfg. Co.
Vent Products
Or Equivalent

E. Type: Louvers shall be combination “Stationary Adjustable Drainable” type with a drain gutter in each stationary blade and downspouts in jambs. Stationary blades and adjustable blades shall be contained within a single 6" louver frame. Adjustable section shall include low leakage blades and jamb seals. Louvers shall be extruded 6063-T5 aluminum alloy construction as follows:

1.	Frame:	0.125" wall thickness.
2.	Blade:	Stationary front section 0.081" wall thickness, 37 1/2□ angle on approximately 4 ½" centers. Adjustable rear section 0.125" wall thickness, double skin airfoil.
3.	Seals:	Extruded vinyl blade edge seals on rear adjustable blades and flexible, compressible aluminum jamb seals.
4.	Linkage:	Concealed.
5.	Bearings:	Stainless steel sleeve pressed into frame.
6.	Axles:	½" plated steel, hexagonal.

7. Operator: Electric motor, 2-position action, 120 volt; spring return with integral spiral-spring mechanism; completely oil-immersed and sealed gear trains.

8. Finish: Special coatings are noted in the schedule on the Drawings. If no coating is designated, provide Class I permanodic anodized finish, color to be selected by Owner during submittal review.

9. Performance Rated: As follows for a 24-inch square unit and marked with AMCA Certified Rating Seal.

   a. Louver free area: 1.32 sq. ft.

   b. Static pressure loss: 0.10 inch water gage at an airflow of 830 fpm free area intake velocity.

   c. Water penetration: 0.025 oz. per sq. ft. of free area at an airflow of 1115 fpm free area velocity when tested for 15 minutes.

10. Bird Screen: 1/4" sq. mesh, 0.063 inch diameter.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install louvers in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Locate and place louver units plumb, level, and in proper alignment with adjacent work.

C. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.

D. Form closely fitted joints with exposed connections accurately located and secured.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Repair finishes damaged by cutting, welding, soldering, and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items which cannot be refinished in field to shop, make the required alterations and refinish entire unit, or provide new units.

G. Protect nonferrous metal surfaces from corrosion or galvanic action by application of a heavy coating of bituminous paint on surfaces which will be in contact with concrete, masonry, or dissimilar metals.

H. All louvers shall be supplied by the same manufacturer.

I. Install electrical connections for power, controls, and devices.

J. Provide and coordinate flashing with masonry Contractor..

K. Provide epoxy coated steel flashing in openings where louvers do not totally cover all cut sides in masonry openings.

END OF SECTION

SECTION 15855

AIR GRILLES, REGISTERS AND DIFFUSERS

PART 1 - GENERAL

1.01 GENERAL

A. ARI Compliance: Test and rate registers, grilles, and diffusers in accordance with ARI Standard 650.

B. NFPA Compliance: Construct and install air outlets and inlets in accordance with NFPA 90A.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the contract, including General Conditions Divisions 0 and 1, and Section 15010 of these specifications.

1.03 SUBMITTALS

A. Submittals: Submit manufacturer's technical product data, assembly-type shop drawings, and maintenance data for each different type of diffuser, grille and register.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Furnish and install all diffusers, registers, grilles and louvers where shown on the drawings, as manufactured by Titus, Anemostat, E.H. Price, Metal Industries, Kruger, Nailor Ind., Tuttle & Bailey, Carnes, American Warming, Arrow, Vent Products, Airstream, Ruskin, Louvers & Dampers, or equivalent. Titus is the basis of design and all manufacturers must meet the requirements listed below. Units shall be of the sizes and capacities as shown in the schedule on the drawings.

2.02 GRILLES, REGISTERS, AND DIFFUSERS

A. 300R Specification

Steel supply grilles shall be Titus Model 300R (double deflection) of the sizes and mounting types shown on the plans and outlet schedule. The deflection blades shall be available parallel to the long or short dimension of the grille or register. Construction shall be of steel with a 1-1/4” wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be spaced on ¾” centers. Blades shall have steel friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable.

Optional opposed blade volume damper (where noted on the schedule) shall be constructed of heavy gauge steel. Damper must be operable from the face of the register.

The grille finish shall be #26 white, or mill finish – see schedule on the drawings. The finish shall be an anodic acrylic paint, baked at 315 degrees Fahrenheit for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Slat Spray Test without creepage, blistering, or deterioration of film. The paint shall pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

B 350/355 Specification

Steel return grilles shall be Titus Model 355ZR (3/4” blade spacing) of the sizes and mounting types shown on the plans and outlet schedule. The fixed deflection blades shall be available parallel to the long or short dimension of the grille or register. Construction shall be of steel with a 1-1/4” wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be held firmly in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at zero degrees.

Optional opposed blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the register.

The grille finish shall be #26 white or mill finish – see drawings. The finish shall be an anodic acrylic paint, baked at 315 degrees Fahrenheit for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Slat Spray Test without creepage, blistering, or deterioration of film. The paint shall pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

The manufacturer shall provide published performance data for the grille. The grille shall be tested with ANSI/ASHRAE Standard 70-1991.

C. 50F Specification

Return grilles shall be Titus Model 50F for the sizes and mounting types as shown on the plans and outlet schedule. Return grilles must provide a free area of at least 90 percent. Outer borders shall be constructed of heavy extruded aluminum with a thickness of 0.040”-0.050” and shall have countersunk screw holes for a neat appearance. Border width shall be 1-1/4” on all sides and shall be interlocked at the four corners and mechanically staked to form a rigid frame. Choice of three sizes of aluminum grid: ½”x1/2”x1/2”, ½”x1/2”x1”, or 1”x1”x1” shall be available.

Optional opposed blade volume damper shall be constructed of heavy gauge steel or aluminum. Damper must be operable from the face of the register.

The grille finish shall be #26 white, or other color per schedule on the Drawings. The finish shall be an anodic acrylic paint, baked at 315 degrees Fahrenheit for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Slat Spray Test without creepage, blistering, or deterioration of film. The paint shall pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

D. TMR Specification

Round ceiling diffusers shall be Titus Model TMR (steel). The TMR shall have three round cones and round neck inlets of the sizes and mounting types shown on the plans and outlet schedule. Two horizontal discharge settings shall allow the diffuser to be field adjusted for different flow rate conditions. The two inner cones must be easily removable as a unit using a spring lock mechanism. Round diffusers shall be constructed of 18 gauge steel.

The finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315 degrees Fahrenheit for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100 hour ASTM D117 Corrosive Environments Slat Spray Test without creepage, blistering, or deterioration of film. The paint shall pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

Optional round damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the diffuser. A retainer cable shall be provided to allow the inner core assembly to hang during maintenance of diffusers with a neck size of 12” or greater.

The manufacturer shall provide published performance data for the linear bar diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

E. 350 Ceiling and Side Wall Diffusers:

Steel return grilles shall be TITUS Model 350R (3/4” blade spacing) or 355R (1/2” blade spacing) of the sizes and mounting types shown on the plans and outlet schedule. The fixed deflection blades shall be available parallel to the long or short dimension of the grille or register. Construction shall be of steel with a 1 ¼” wide border on all sides. Screw holes shall be countersunk for a neat appearance. Corners shall be welded with full penetration resistance welds.

Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be firmly held in place by mullions from behind the grille and fixed to the grille by welding in place. Blade deflection angle shall be available at 0° (Models 350ZR and 355ZR) or 35° (Models 350R and 355R).

Optional opposed blade volume damper shall be constructed of heavy gauge steel. Damper must be operable from the face of the register.

The grille finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint shall pass a 100 hour ASTM D117 Corrosive Environments Salt Spray Test without creepage, blistering, or deterioration of film. The paint must pass a 250 hour ASTM-870 Water Immersion Test. The paint must also pass the ASTM D-2794 Reverse Impact Cracking Test with a 50 inch pound force applied.

The manufacturer shall provide published performance data for the grille. The grille shall be tested in accordance with ANSI/ASHRAE Standard 70-1991.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General: Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Coordinate with other work, including light fixtures, skylights, ductwork and duct accessories, etc. as necessary to interface installation of air outlets and inlets with other work.

C. Contractor shall provide all necessary duct stubs, collars, and transitions to installed the diffusers or grilles accordingly. See detail on the drawings for additional requirements.

END OF SECTION

SECTION 15996

TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow for the heat pump distribution systems and for each new fan on the project, including submains, branches, and terminals, to indicated quantities within +/-5% tolerance.

2. Adjusting total HVAC systems to provide indicated quantities.

3. Measuring electrical performance of HVAC equipment.

4. Setting quantitative performance of HVAC equipment.

5. Verifying that automatic control devices are functioning properly.

6. Reporting results of the activities and procedures specified in this Section.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Drawings and general provisions of the contract, including General Conditions Divisions 0 and 1, and Section 15010 of these specifications.

1.03 SUBMITTALS

A. Certified Testing, Adjusting, and Balancing Reports: Submit copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

1.04 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.

2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing Agent's standard forms approved by the Engineer.

D. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

1.05 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

M. AABC: Associated Air Balance Council.

N. AMCA: Air Movement and Control Association.

O. CTI: Cooling Tower Institute.

P. NEBB: National Environmental Balancing Bureau.

Q. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.06 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.07 WARRANTY

A. General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.

2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine project record documents described in Division 1 Section "Project Record Documents."

D. Examine Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume

dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.

2. Dampers and valves are in the position indicated by the controller.

3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multi-zone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including 2-way valves and 3-way mixing and diverting valves, are properly connected.

5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.

6. Sensors are located to sense only the intended conditions.

7. Sequence of operation for control modes is according to the Contract Documents.

8. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.

9. Interlocked systems are operating.

10. Changeover from heating to cooling mode occurs according to design values.

M. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

3.02 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.

2. Automatic temperature-control systems are operational.

3. Equipment and duct access doors are securely closed.

4. Isolating and balancing valves are open and control valves are operational.

5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

6. Windows and doors can be closed so design conditions for system operations can be met.

3.03 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC, NEBB, or SMACNA national standards and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

C. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.04 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

C. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

D. Verify that motor starters are equipped with properly sized thermal protection.

E. Check dampers for proper position to achieve desired airflow path.

F. Check for airflow blockages.

G. Check condensate drains for proper connections and functioning.

H. Check for proper sealing of air-handling unit components.

3.05 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating if high-efficiency motor.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

3.07 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Fan curves.

2. Manufacturers' test data.

3. Field test reports prepared by system and equipment installers.

4. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.

2. Name and address of testing, adjusting, and balancing Agent.

3. Project name.

4. Project location.

5. Engineer's name and address.

6. Engineer's name and address.
7. Contractor's name and address.

8. Report date.

9. Signature of testing, adjusting, and balancing Agent who certifies the report.

10. Summary of contents, including the following:

    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
11. Nomenclature sheets for each item of equipment.

12. Data for terminal units, including manufacturer, type size, and fittings.

13. Notes to explain why certain final data in the body of reports vary from design values.

14. Test conditions for fan performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings, including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

E. Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data: Include the following:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches (mm), and bore.
i. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
j. Number of belts, make, and size.
k. Number of filters, type, and size.

2. Motor Data: Include the following:

a. Make and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Outside airflow in cfm (L/s).
f. Return airflow in cfm (L/s).
g. Outside-air damper position.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).

2. Motor Data: Include the following:

a. Make and frame type and size.

b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.
b. Location and zone.
c. Traverse air temperature in deg F (deg C).
d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. ((sq. m)).
g. Design airflow rate in cfm (L/s).
h. Design velocity in fpm (m/s).
I. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

H. Air-Terminal-Device Reports: For terminal units, include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device number from system diagram.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).

3. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm (L/s).
e. Air temperature in deg F (deg C).

3.08 ADDITIONAL TESTS

A. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work included in this section of the Specifications includes the furnishing of all labor, material, tools, approvals, utility connection fees, excavation, backfill, and other equipment and services necessary to install the electrical system as shown on the Contract Drawings and as specified herein. It also includes the connection of all equipment included in this Contract but furnished by other contractors or suppliers.

B. The Contractor shall furnish and install all conduit, wire, safety switches and miscellaneous material to make all electrical connections to all items of equipment or wiring devices indicated in the Drawings or Specifications except as otherwise specified.

C. All devices and items of electrical equipment, including those shown on the Contract Drawings but not specifically mentioned in the Specifications or those mentioned in the Specifications but not shown on the Contract Drawings, are to be furnished under this section of the Specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar equipment and/or devices specified herein.

D. Bidders are required to visit the construction site prior to submitting a bid and carefully examine the Contract Drawings and Specifications so that he/she may fully understand what is to be done and to document existing conditions. Any discrepancies, questions, or omissions must be brought to the attention of the Engineer at least 10 days prior to the bid opening date. Extras will not be approved for work that the Contractor should have seen beforehand by visiting the site prior to bidding.

E. It is the general intent that all motors (except for replacement motors) shall be furnished with the particular object of equipment it drives by the supplier furnishing the equipment. Motor controls and related equipment shall be furnished by the Division 16 supplier unless specifically noted otherwise in these Specifications or on the Drawings.

F. Where wiring diagrams are not shown on the Contract Drawings, they shall be provided by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.

1.02 RELATED WORK

A. Division Zero and 1: Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between the Basic Electrical Requirements and the above-mentioned documents, the above-mentioned documents shall overrule this section. The Basic Electrical Requirements are intended as a supplement to the above-mentioned documents. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of proposal.

B. Contractor shall carefully examine the entire set of Contract Drawings and all Divisions of the Specifications.

1.03 SUBMITTALS

A. Shop Drawings including descriptive literature and/or installation, operation and maintenance instructions shall be submitted in the amount of copies per the General Conditions for this Division. All Shop Drawings shall be submitted in loose-leaf three-ring cardboard reinforced vinyl binders. A shop drawing submittal shall be prepared for each Section of this Division.

B. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Non-applicable catalog data shall be marked out. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature. For example: Device boxes – Styles shall be listed as: For masonry walls, for electrical devices, for ceiling mounted light fixtures, etc. Proposed options must be highlighted, underlined, etc.

C. The Engineer reserves the right to make modifications to motor control and power distribution equipment ratings after equipment Shop Drawing review, if the equipment Shop Drawings are submitted prematurely (prematurely meaning submitted before all utilization equipment has been reviewed and accepted). Cost of modifications shall be the Contractor’s responsibility.

D. O&M manuals must be submitted for all equipment. The O&M manuals shall be assembled in three-ring binders with front and binder-edge labels. The first and last few pages shall have sheet hole protectors to prevent the pages from tearing out. O&M manuals must include the following information:

1. Vendor and contractor information, addresses, phone numbers, email, websites, etc.
2. Equipment cutsheets with detailed model number breakdown suitable for procuring replacement equipment. It is best to insert the approved shop drawing cutsheets into the O&M manuals, unless field changes necessitate otherwise. Non-applicable information must be marked out, and selected options must be highlighted.
3. Operation instructions

4. Maintenance instructions
5. Drawings, wiring diagrams, etc.
6. Copy of required testing results
7. Copy of inspection certificates
8. A compact disc holder with compact disc containing a PDF format copy of all O&M information. At Contractor's option, a CD can be submitted (in the quantity required for O&M manuals) containing the O&M information for the entire electrical system rather than with each O&M manual.

E. AutoCAD floor plans are available in electronic format for a fee of $100 per sheet. Contact the Engineer to obtain these floor plans.

1.04 SYMBOLS AND ABBREVIATIONS

A. The symbols and abbreviations generally follow standard electrical and architectural practice; however, exceptions to this shall be as shown on the Contract Drawings.

1.05 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the electrical work with that of other trades to ensure proper final location of all electrical equipment and/or connections. The Contractor shall verify door swings to see that light switches are located properly.

1.06 CODES

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC) and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineer's design require a higher standard that the current NEC or KBC, then these laws and/or regulations and/or the design shall be followed.

1.07 INSPECTIONS AND PERMITS

A. Inspection of the electrical system on all construction projects is required. It is the Contractor's responsibility to pay for and obtain all permits, pay all fees, and coordinate the activity of inspections. The Contractor shall notify the electrical inspector in writing, immediately upon notice to proceed, and a copy of the notice shall be submitted to the Engineer. No work shall be concealed unless acceptable to the inspector.

B. At the time of completion of the project, there shall be furnished to the Owner a certificate of compliance, from the agency having jurisdiction pursuant to all electrical work performed. The Engineer shall also receive a copy in the O&M manual submittal.

1.08 STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

B. Sensitive electrical equipment such as light fixtures, motor starters, control panels, and panelboards, delivered to the job site, shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed. Electrical equipment other than boxes and conduit shall not be installed until the structure is under roof with doors and windows installed.

C. No light fixtures or device plates shall be hung or installed until after painting is completed.

1.09 ERRORS, CORRECTIONS, AND/OR OMISSIONS

A. Should a piece of equipment be supplied of a different size or horsepower than shown on the Contract Drawings, the Contractor shall be responsible for installing the proper size wiring, conduit, starters, circuit breakers, etc., for proper operation of that unit and the complete electrical system at no extra cost to the Owner.

B. It is the intent of these Specifications to provide for an electrical system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractor's failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost. Further requirements on this subject may be found in the General Requirements.

C. Necessary changes or revisions in electrical work to meet any code or power company requirement shall be made by the Contractor without additional charge.

1.10 GUARANTEES AND WARRANTIES

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of the electrical system or improper equipment operation. It shall last for the period of time specified in the General Conditions of the Contract, but not less than one year from the date of substantial completion.

B. Repair and maintenance for the guarantee period is the responsibility of the Contractor and shall include all repairs and maintenance other than that which is

considered as routine. (That is oiling, greasing, etc.) The Engineer shall be the judge of what shall be considered as routine maintenance.

C. Certain equipment is required to have longer warranty periods than that specified in the General Conditions. See the individual sections for these warranty requirements.

1.11 POWER COMPANY COORDINATION

A. The Contractor is responsible for coordinating all activities onsite by the power company.

B. Contractor is required to install metering per utility requirements.

C. Any special provisions required by the serving electrical utility shall be as outlined on the Contract Drawings or as advised by the utility at the time of construction, and work required by these special provisions shall be executed with no extra cost to the Owner.

1.12 TEMPORARY ELECTRICAL POWER AND LIGHTING

A. The Contractor shall be responsible for providing temporary electrical power and lighting as required during the course of construction and shall remove the temporary service equipment when no longer required. Temporary power is also addressed in general and special requirements.

1.13 TRAINING

A. All manufacturers supplying equipment for this division shall provide the Owner's operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer. Refer to individual equipment specifications for training requirements.

1.14 RECORD DRAWINGS

A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these drawings, from day to day, the actual record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

B. Specific attention shall be given to the exact location of any underground lines installed under this Contract. These lines shall be dimensioned to easily identifiable points on permanent structures.

1.15 MAINTAINING CONTINUOUS ELECTRICAL SYSTEM AND SERVICE

A. Existing service(s) continuity shall be maintained at all times. In no way shall the installation and/or alteration of the electrical work interfere with or stop the normal operation of the existing facilities, except where acceptable to the Owner and prior arrangements have been made.

B. When additions and taps to existing service(s) require electrical outages, arrangements shall be made in advance for such outages. All outages shall be held to an acceptable minimum with none exceeding 8 hours continuous duration. If necessary, cuts shall be performed on premium time. If performed at night, requiring a general outage, the Contractor shall furnish an auxiliary source of light and power as required. Under no circumstances shall an electrical outage of any duration be initiated until the Owner and Engineer have concurred, and as far as possible in advance.

1.16 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the Contractor. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per Power Company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the Contractor's responsibility to contact the utility prior to bidding and obtain any special requirements or costs they will be imposing. Those costs shall be included in the bid.

C. On underground service entrances from pad mounted transformers, the Contractor shall be responsible for furnishing and installing all primary, secondary, and metering conduits, as well as secondary service/metering conductors. The Contractor shall be responsible for furnishing pull wires in primary conduits for use by the power company. The Contractor shall be responsible for fabricating the required concrete pad that the transformer will be mounted on. The Contractor shall also mount the meter base or C.T. cabinet when furnished by the power company.

1.17 CONTRACTOR LICENSING

A. The Contractor performing the electrical work on this project shall be a licensed electrical contractor in the state of Kentucky.

1.18 RECEIPTS

A. Some sections of the Specifications call for equipment, materials, accessories, etc. to be provided and "turned over to the Owner" or like requirements. The

Contractor shall obtain a receipt for each item turned over, signed by the Owner or his representative. A copy of this receipt shall be transmitted to the Engineer.

B. When a question arises concerning whether items have been turned over to the Owner, and there is no signed receipt, it may be assumed that the items were not provided.

1.19 DEFINITIONS

A. Furnish – Procure equipment/materials and deliver and unload at the project site.

B. Install – Enter the equipment/materials permanently into the project and make operational.

C. Provide – Furnish and Install

D. NEC – National Electrical Code

1.20 HAZARDOUS LOCATIONS

A. Electrical materials and equipment for installation in hazardous locations, as defined in the NEC and as indicated on the Drawings, shall be specifically approved by UL or FM for the particular Class, Division and Group of the location involved.

1.21 EQUIPMENT CONFIGURATION/PROGRAMMING

A. Any equipment furnished by the Contractor is required to be configured or programmed by the Contractor or his subcontractor/vendor. Any necessary studies or engineering necessary to configure or program this equipment shall be provided by the Contractor as needed to place the equipment into successful operation. Engineer or Owner will not be responsible for equipment configuration or programming.

B. If a manufacturer or manufacturer's representative is required to startup/commission the equipment in these Specfications, then it is required that the Contractor provide the services of the manufacturer to configure/program the equipment. This includes the provision of any necessary studies or engineering necessary for the configuration/programming.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials used shall be new and at least meet the minimum standards as established by the NEC and/or National Electrical Manufacturers Association

(NEMA). All materials shall be UL listed for the application, where a listing exists. All equipment shall meet applicable FCC requirements and restrictions.

B. The reuse of salvaged electrical equipment and/or wiring will not be permitted unless specified herein or indicated on the Contract Drawings.

C. All salvaged or abandoned electrical materials shall become the property of the Contractor and shall be removed from the job site upon completion of the project, unless otherwise noted on the Contract Drawings or specified herein.

D. Existing fluorescent light fixtures to be abandoned and removed this Contract, shall be assumed to be equipped with PCB filled ballasts. Light fixtures shall be disassembled and the ballast removed prior to salvage and/or disposal. Ballasts containing PCB's shall be disposed per requirements of the Toxic Substances Control Act (TSCA). Manifests shall be submitted to the Owner documenting proper transportation and disposal of PCB contaminated ballasts.

E. All materials must be rated for the temperature range expected to be encountered in the application indicated on the Drawings. If there are any questions regarding the temperature range, contact the Engineer 10 days prior to bid opening date. No extras will be allowed for materials proposed that do not have an acceptable temperature range.

2.02 OVERCURRENT AND OVERLOAD PROTECTION

A. Circuit breakers or fused switches shall be the size and type as written herein and shown on the Contract Drawings. Any additional overcurrent protection required to maintain an equipment listing by an authority having jurisdiction shall be installed by the Contractor at no extra cost to the Owner.

B. The Contractor shall submit actual nameplate data from motors shipped to the site, stating motor identification as well as characteristics. Overload relay thermal unit selection tables shall accompany the motor data. The Contractor shall select and highlight thermal unit sizes from this data and shall include this information in the O&M Manuals.

2.03 STEEL COVER PIPE

A. Steel cover pipe shall be furnished and installed as a sleeve to protect conduits that travel under roads or in boring/jacking installations. Pipe shall be plain end steel pipe with yield strength of 35,000 psi minimum and tensile strength of 60,000 psi minimum. It shall be manufactured per API-5L specifications. Minimum wall thickness shall be .188" under 10" size and .25" for 10" or 12" size.

2.04 POWER OUTAGE

A. All equipment provided shall restart automatically after a power outage is restored, unless specifically exempted by Engineer due to safety concerns.

PART 3 – EXECUTION

3.01 GENERAL ELECTRICAL INSTALLATION

A. Equipment connections shall be made with flexible or rigid conduit as required. Controllers for motors, safety switches, and all control, protective and signal devices for motor circuits, except where such apparatus is furnished mounted and connected integrally with the motor driven equipment, shall be installed, connected and left in operating condition. The number and size of conductors between motors and control or protective apparatus shall be as required to obtain the operation described in these Specifications, and/or by the Contract Documents, and/or as shown in manufacturer-furnished Engineer reviewed Shop Drawings.

B. All raceways and wiring shall be firestopped where required by code and/or indicated in the Contract Drawings, as specified in Section 15305.

3.02 CUTTING AND PATCHING

A. Cutting and patching shall be held to an absolute minimum and such work shall be done only under the direction of the Owner's representative. The Contractor shall be responsible for and shall pay for all openings that may be required in the floors or walls, and he shall be responsible for putting said surfaces back in their original condition. Every attempt shall be made to avoid cutting reinforcing steel bars when an opening is required in a reinforced concrete wall or floor slab.

B. Prior to cutting of any floors or walls, all conduits must be located prior to the cutting through the use of sounding test equipment. Such equipment is readily available through rental companies. If a pipe or electrical circuit is damaged during cutting/demolition the Contractor shall repair the damaged item back to original condition. Absolutely no extras will be allowed for the replacement of damaged electrical conduits, pipes, etc. in floors walls, and ceilings that are to remain.

3.03 CLEANUP

A. Cleanup shall be completed as soon as possible after the electrical installation is complete and as required throughout the project construction by the Owner. All equipment supplied under this Division shall be free of shipping tags, dust, stickers, shavings, filings, drill cuttings, etc. All painted equipment shall be left free of scratches or other blemishes, such as splattered or blistered paint, etc. Surplus material, rubbish and equipment resulting from the work shall be removed

from the job site by the Contractor upon completion of the work. All existing equipment must be thoroughly cleaned by the Contractor in the vicinity of the construction area.

B. During construction, cover all Owner equipment and furnishings subject to damage or contamination in any way.

3.04 EXCAVATION AND BACKFILL

A. Excavation for conduits shall be of sufficient width to allow for proper jointing and alignment of the type conduit used. Conduit shall be bedded on original ground. Where conduit is in solid rock, a 6-inch earth cushion must be provided. Conduit shall be laid in straight lines between pull boxes and/or structures unless otherwise notes on the Contract Drawings. The cost of solid rock excavation shall be included in the lump sum bid with no extra pay allowed (unclassified).

B. Backfill shall be as detailed on the Drawings. Dirt within 6” of the conduits shall be hand placed, loose granular earth. It shall be free of rocks over ½ inches in diameter. Above 6”, large rocks may be included but must be mixed with sufficient earth to fill all voids.

3.05 SLEEVES, CHASES AND OPENINGS

A. Sleeves shall be required at all points where exposed conduits pass through new concrete walls, slabs, or masonry walls. Sleeves that must be installed below grade or where subject to high water conditions must be installed watertight.

B. Wiring chases shall be provided where shown on the Contract Drawings. The Contractor shall have the option of installing chases below surface mounted panelboards provided all structural requirements are met.

C. It is the Contractor’s responsibility to leave openings to allow installation of the complete, operational electrical system. Openings required but not left shall be cut as outlined under cutting and patching. The Contractor shall coordinate all holes and other openings with necessary diameters for proper firestopping.

3.06 GROUNDING AND BONDING

A. All metallic conduit, cabinets, equipment, and service shall be grounded in accordance with the latest issue of the National Electrical Code. All supporting framework and other metal or metal clad equipment or materials which are in contact with electrical conduit, cable and/or enclosures, shall be properly grounded to meet the code requirements.

3.07 ANCHORING/MOUNTING

A. Electrical conduits and/or equipment shall be rigidly supported. Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type. Plastic or explosive type anchors are prohibited.

B. Contractor shall provide all necessary supports in accordance with KBC Seismic requirements.

3.08 ELECTRICAL COMPONENT MOUNTING HEIGHTS

A. Unless otherwise indicated, mounting height for components shall be as defined on the Drawings.

3.09 TESTING

A. After the wiring system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating test for acceptance. The equipment shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, as well as the necessary electrical power.

B. Before energizing the system, the Contractor shall check all connections and set all relays for proper operation. He/she shall obtain all necessary clearances, approvals, and instructions from the serving utility company and/or equipment manufacturers prior to placing power on the equipment.

C. Tests may be performed by the Engineer to determine integrity of insulation on wiring circuits selected by the Engineer at random.

D. Cost of utilities for testing done prior to beneficial occupancy by the Owner shall be borne by the Contractor.

3.10 BORING OR JACKING

A. Boring or jacking may be allowed with permission of the Engineer. Boring or jacking shall be performed by mechanical means and accurate vertical and horizontal alignment must be maintained. Steel cover pipe shall be used and shall be installed inside bored holes concurrently with boring or jacking. All joints shall be solidly welded. The weld shall be such that the joint shall be of such strength to withstand the forces exerted from boring and jacking operation as well as the vertical loading imposed on the pipe after installation. The weld shall also be such that it provides smooth, nonobstructing joint in the interior of the pipe. Spacers on 5’ centers shall be installed to separate the conduits from the cover pipe. No greater than ½” of movement is acceptable after spacers are installed.

3.11 DEMOLITION

A. For equipment indicated to be demolished, remove all conduit, boxes, wiring, switches, and controls associated with the equipment. Concealed conduit may be abandoned in place. All walls, floors, ceilings, and surfaces must be patched and painted to match surrounding surface after demolition is complete.

END OF SECTION

SECTION 16060

SECONDARY GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Grounding shall be provided in accordance with the NEC, as described in these Specifications, and as shown on the Contract Documents.

1.02 RELATED DOCUMENTS

A. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Submittals are required on all grounding equipment in accordance with Section 16010.

1.04 QUALITY ASSURANCE

A. Codes and Standards

1. NEC Compliance: Grounding must conform to NEC requirements.

2. UL Compliance: Comply with applicable requirements of UL Standard No. 467 “Electrical Grounding and Bonding Equipment” and No. 869, “Electrical Service Equipment.” All grounding and bonding products shall be UL listed and labeled for their intended usage.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Grounding equipment shall be Cadweld, Thomas and Betts/Blackburn, Erico, Copperweld Bimetallics Group, Cathodic Engineering Equipment Co., or equal.

2.02 GROUND RODS

A. Ground rods shall be copper-clad steel with minimum diameter of ¾” and length of 10’. They shall confirm to UL467 requirements.

2.03 GROUND CONDUCTORS

A. Conductors shall be copper and sized as indicated on the Drawings. If size is not indicated than the conductors shall be sized according to the NEC.

2.04 GROUND MESH / EQUIPOTENTIAL BONDING GRID

A. Provide a prefabricated mesh constructed of #8awg (minimum) copper on 12” x 12” grid. The mesh shall be Erico, or equal. Connections shall be via exothermic welding process.

2.04 GROUNDING ACCESSORIES

A. Provide all grounding accessories necessary for a complete, functional, code-compliant grounding system. This includes but is not limited to the following: connectors, lug terminals, electrodes, bonding jumpers, surge arresters, tape, heat-shrink tubing, exothermic welding materials, bonding straps, etc.

2.05 GROUND ENHANCEMENT MATERIAL

A. Ground enhancement material shall be GEM by Erico Products, Powerfill by Cathodic Engineering Equipment Company, or equal.

B. The ground enhancement material must be permanent and maintenance free (no recharging with salts or chemicals which may be corrosive) and maintain its earth resistance for the life of the system. It must set up firmly and not dissolve or decompose, or otherwise pollute the soil or local water table. The material shall be capable of being applied dry or in a slurry form, and shall reduce resistance by at least 40 percent.

C. Basic components of this material shall be carbon, hydraulic cements, and hydrous aluminum silicates. Minimum 4-inch diameter holes shall be used with ground rod installations, with depth 6" shorter than length of rod, completely filled with the material. Trenches for grounding electrode conductor shall also utilize this material the full length from electrode to building, in accordance with manufacturer installation recommendations, except trench depth shall allow buried conductor to be at least 2'-6" deep.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Grounding shall utilize a supplemental driven ground rod system in a bed to achieve the design ground resistance.

B. The ground system shall be continuous with all structures on a common ground. This can be accomplished by bonding all conduits together and bonding to the ground bus at each motor control center. Bonding jumpers shall be required at all pull boxes, and at all motor casings. A separate grounding conductor shall be pulled in all conduits in addition to wire counts shown on Drawings.

C. Where multiple rods are driven, they shall be separated by at least 10 feet to assure maximum effect.

D. Ground resistance between ground and absolute earth shall not exceed 5 ohms.

E. All grounding and grounding electrode systems shall be as required by the NEC as for types of electrodes utilized and sizing of grounding conductor to service

equipment from the electrode system. These shall include footer rebar, buried metal water pipe, buried bare copper conductor, etc.

F. All grounding electrode system connections shall be made using exothermic welds, Cadweld, or equal. No splices are allowed in the grounding electrode conductor.

G. Should ground rods be impractical for use due to rocky conditions, then grounding electrode plates may be used after acceptance by the Engineer on a case by case basis.

H. Ground mesh/equipotential grids shall be installed prior to pouring final pavement/concrete and shall be located not less than 2” or more than 3” from top of slab. Install per NEC article 680 or 682 provisions as applicable. The grid must extend at least 3’ horizontally from the metal structure that it surrounds, and must be bonded with a minimum #8 conductor to the grounding electrode system for the structure.

3.02 FIELD QUALITY CONTROL

A. Testing

1. The Contractor shall provide all labor, tools, instruments, and materials as necessary to perform testing of the grounding electrode system. Results shall be submitted in writing to the Engineer. The testing shall be done to determine the effectiveness of the selected grounding scheme and to see that it conforms with resistance specified (5 ohms maximum).

2. The testing should be done using a fall-of-potential method test at the point of grounding electrode conductor connection to main power distribution equipment and at each separately derived system or MCC. The test shall be performed no sooner than 48 hours after a rainfall event.

3. The written report should contain the following information:

a. Type of ground scheme used, i.e., building steel, driven rod, mat, etc.

b. Type of instrument used.

(1) Manufacturer
(2) Model Number
(3) Confirm fall-of-potential test
(4) *Serial Number
(5) *Where instrument was obtained

*These 2 items are required so that the same instrument may be utilized should reproduction of the test be necessary due to unsatisfactory readings/instrument miscalibration.

c. Ground resistance readings obtained at various test distances.

d. Ground resistance/distance curve.

e. Value of Grounding Electrode Resistance at knee of curve.

f. Sketch showing setup of instrumentation and location of grounding electrode and test probes.

g. Proposed method to achieve the specified resistance, should an unacceptable reading be obtained.

h. Ground resistance readings obtained (if applicable) after modifications incorporated.

3.03 GROUND ENHANCEMENT MATERIAL

A. Where indicated on the Drawings or as deemed necessary by the Contractor to achieve design grounding electrode system resistance, a ground enhancement material shall be utilized, in accordance with manufacturer's recommendations.

END OF SECTION

SECTION 16070

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. All electric equipment shall be rigidly mounted and installed using supporting devices as indicated on the Contract Drawings, as required by the work, and as described herein.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Submittals are required in accordance with Section 16010 requirements.

1.04 QUALITY ASSURANCE

A. Electrical components shall be listed and labeled by UL, ETL, CSA, or similar.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Strut: “Kindorf,” “Unistrut,” “B-Line,” “Allied Tube & Conduit,” or equal.

2.02 STRUT

A. Galvanized: Either pre-galvanized, ASTM A653 with G90 coating, or hot-dip galvanized per ASTM A123. Accessory hardware shall be ASTM B633 zinc-plated.

B. Aluminum: Extruded alloy 6063-T6. Accessory hardware shall be stainless steel type 18-8 or 304.

C. Stainless Steel: AISI Type 304 or 316. Accessory hardware shall be stainless steel type 18-8, 304, or 316.

D. Fiberglass resin strut shall be used in chemical areas and areas exposed to chlorine gas. Hardware shall be 316 stainless steel.

2.03 HARDWARE

A. All hardware for interior (non-NEMA 4X) applications shall be zinc-plated.

B. All hardware for exterior applications shall be stainless steel type 18-8 or 304 or 316.

C. All hardware for NEMA 4X areas, chemical areas, or otherwise wet/corrosive areas shall be stainless steel Type 316.

PART 3 - EXECUTION

3.01 ANCHORING CABINETRY

A. All free standing equipment shall be anchored to its foundation using expansion bolts of the size and number recommended by the equipment manufacturer.

3.02 ANCHOR METHODS

A. Concrete: Expansion anchors, preset inserts, or purpose made anchors.

B. Hollow Masonry: Toggle bolts or expansion anchors.

C. Wood Surfaces: Wood screws (#10 min) or lag bolts.

D. Metal Surfaces: Machine screws or bolts.

3.03 STRUT INSTALLATION

A. Table of Acceptable Usage:

AREA	STRUT MATERIALS
Industrial Interior	Galvanized, Aluminum, Stainless
Industrial Exterior	Aluminum, Stainless
NEMA 4X (non-chemical) Areas	Stainless
NEMA 4X Chemical Areas	Fiberglass Resin

B. The only exception to the above shall be anchor bolts for area lightpoles which shall be allowed to have galvanized threads and galvanized nuts.

C. Galvanized strut, where cut in the field, must have ends filed smooth and cold galvanized.

D. All field-cut strut shall have ends filed smooth and free of burrs or sharp edges. Any strut installed within 7 feet above finished floor must have protective foam edging applied to prevent injury to personnel.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide electrical identification of equipment, boxes, and conductors as specified herein.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Submittals are required for electrical identification products in accordance with Section 16010 requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Brady, Safety Sign Company, Seton or equal.

2.02 ELECTRICAL IDENTIFICATION PRODUCTS

A. Engraved, Plastic Laminated Labels and Signs: Shall be engraved stock melamine plastic laminate, 1/16 inch minimum thickness, and shall have white plate with black letters.

B. Vinyl self-adhesive signs: Shall warn of “High Voltage” (state the specific voltage). The type of labels to be used shall have orange as the basic color to conform with OSHA requirements, and letters shall be black. The labels shall be of proper size to fit flatly on the surface of the enclosure to make for a neat appearance and not interfere with the operating function of the device it is attached to.

C. Colored Adhesive Marking Tape for Wires and Cables: Self-adhesive, vinyl tape not less than 3 mils thich by 1 inch in width.

D. Conductor Labels: Shall be machine printed, heat-shrink type.

E. Underground line marking tape: Permanent, red-colored, continuous printed, not less than 6 inches wide and 4 mils thick. Tape shall have metal-backing suitable for tracing.

PART 3 - EXECUTION

3.01 EQUIPMENT LABELING

A. All starters, feeder units in panelboards, disconnects, instruments, etc. shall be marked to indicate the motor, outlet, or circuit they control. Marking is to be done with engraved laminated nameplates and shall bear the designation shown on the Contract Drawings where this information is given. Nameplates shall be fastened to equipment with stainless steel screws, minimum of one each side. In no way shall the installation of mounting screws void the NEMA enclosure rating of the equipment in which they are installed. Nameplate background color shall be white, with black engraved letters, unless otherwise noted. Typical panelboard label:

"Panel PP1
225A 480Y/277 3PH 4W
Fed From Panel MCP"

Typical Safety Switch Label:

"AHU-5
480V 3PH
Fed From Panel PP1"

Typical Instrument label:

"PIT-501
High Service Discharge Pressure"

B . All cabinets, disconnect switches, control panels, transfer switches, panelboards etc. shall be additionally labeled with orange OSHA-compliant vinyl self-adhesive signs that list the maximum voltage contained inside the cabinet or panel.

C. Branch circuits in lighting panels shall be typed on a card suitable for the card frame furnished with the panel. The card shall bear the panel designation listed on the Contract Drawings where this information is given, as well as indicate what each circuit controls. The Contractor shall retype new cards for all existing panelboards modified.

D. Submersible pumps shall be furnished with a spare nameplate which shall be installed inside the MCC or starter enclosure.

E. All mechanical equipment on the project that has electrical service shall be labeled and the equipment labels must match the breaker labels. Coordinate with Divisions 2, 11, and 15.

3.02 BOX LABELING

A. Label each box with the voltage and circuit numbers contained.

3.03 CONDUCTOR LABELING

A. Label each conductor to match the circuit number or manufacturer's shop drawing wiring diagrams.

3.04 ARC-FLASH HAZARD LABELING

A. Electrical equipment shall be labeled with Arc-Flash hazard warning labels as required by the N.E.C. Labeling shall comply with ANSI Z535.4.

3.05 AVAILABLE FAULT CURRENT LABELING

A. Service equipment shall be labeled with the maximum available fault current and date of calculation as required by the NEC. Contact Engineer to obtain available fault current value.

END OF SECTION

SECTION 16120

CONDUCTORS, CABLES, AND CIRCUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide conductors, cables, and circuiting as indicated and as specified herein for a complete, functional electrical system.

B. Building wire #12 - #1 shall be applied based on a 60 degree Celsius temperature rise. Building wire larger than #1 may be applied at its 75 degree Celsius temperature rise.

1.02 RELATED WORK

A. Section 16010 – Basic Electrical Requirements

B. Section 16075 – Electrical Identification

C. Division 17 – Instrumentation/SCADA

1.03 SUBMITTALS

A. Submittals are required on all cables and conductors in accordance with Section 16010 requirements.

B. Submittals are required on cable supports.

C. Submit megohm test results as specified herein.

1.04 QUALITY ASSURANCE

A. All wire and cable shall conform to the latest requirements of the NEC and shall meet all ASTM/UL specifications. Wire and cable shall be new; shall have size, grade of insulation, voltage rating and manufacturer's name permanently marked on the outer covering at regular intervals. Complete descriptive literature shall be submitted to the Engineer for review and acceptance prior to installation.

1.05 DELIVERY, STORAGE AND HANDLING

A. Wire and cable shall be suitably protected from weather and damage during storage and handling and shall be in first class condition when installed.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Building Wire (type “THWN”) - “Collyer,” “Rome,” “American,” “Carol,” or equal.

B. Flexible Cords and Cables (Types “SO” (600V) “SJO” - 300V) “Collyer,” “American,” “Carol,” or equal.

C. Power cables, for conduit installation or direct-burial (600V, 5KV or 15 KV) - “Anaconda,” “Okonite,” “Triangle PWC,” or equal.

D. Control Cables (Shielded or unshielded) 600V max. - “Belden,” “Eaton-Dekoron,” “Okonite,” or equal.

E. Instrumentation Cables (Shielded) 600V mx. - “Eaton-Dekoron,” “Manhatton,” “American,” “Belden,” “Okonite,” or equal.

F. Cable Supports – Hubbell/Bryant or equal.

2.02 GENERAL

A. In general, all conductors shall be 98 percent conductive, annealed copper unless otherwise noted on the Contract Drawings.

B. Conductors with high temperature rated insulations and special construction shall be used where required in connecting to light fixtures or appliances that have special requirements.

2.03 GENERAL BUILDING WIRE

A. Conductors shall be type THWN-2 insulation. Conductor size shall be AWG (American Wire Gauge) Standard. Minimum conductor size shall be AWG number 12 except branch circuits in excess of 75 feet from panel to first outlet not smaller than no. 10 AWG. Minimum voltage rating shall be 600 volts. Conductors for small power may be solid (i.e. lighting, receptacles), but conductors for control work shall be stranded.

B. Metal Clad (MC) Cable – Shall comply with NEC and UL 1569.

C. Conductors inside control panels, that do not extend outside the cabinet, shall be Type MTW with a minimum size of 18 gauge and a minimum voltage rating of 600V. Each conductor shall be terminated with a ferrule and a wire label.

2.04 INSTRUMENTATION CABLE

A. Instrumentation cable shall have individually shielded and twisted pairs or triads. Conductors shall be tinned copper, and the cable shall include a separate drain conductor. Voltage rating shall be 600 Volt. Conductor colors shall be black and white. Shielding shall be a combination braid/foil with 100% coverage. Insulation shall be PVC or XLPE. Conductors shall be #18AWG minimum, but no smaller than the size indicated on the Drawings.

B. All signal lines should be constructed of individually twisted pairs (6 to 10 twists per foot), including thermocouple extension leads. Cables should be made of twisted pairs, with all lays and pairs twisted in the same direction for maximum flexibility.

C. Insulation resistance at 68 degrees Fahrenheit between conductors and between conductors and ground should be at least 500 megohms per 1,000 feet.

D. Multi-pair cable should be jacketed with poly-vinyl-chloride, polyethylene or Teflon at least 0.045" thick. Voltage rating shall be 600 volts.

2.05 MULTICONDUCTOR CONTROL CABLE

A. Shall be concentrically cabled No. 14 AWG stranded copper conductors with saturated interstitial fillers; overall binder of nylon or similar material; and PVC jacket. Quantity of conductors shall be as indicated on the Drawings, with 25% spare minimum. Conductor insulation shall be 20 mils of polyethylene with 10 mils PVC, rated 600V.

B. Color coding shall be ICEA, Method 1.

2.06. SUBMERSIBLE PUMP POWER CABLE

A. Power cables for submersible pumps shall be of the extra hard usage type suitable for submerged duty and able to withstand common corrosive agents found in water and wastewater. They shall be provided with high grade non-magnetic stainless steel relief cable grips installed at the pump end and high grade non-magnetic stainless steel support cable grips anchored to the wet well structure where they enter the wet well. All submersible pump cable shall be listed for Class I Div. I Group D areas.

2.07. CABLE SUPPORT GRIPS

A. The strain relief and support cable grips shall be as manufactured by Hubbell/Bryant or equal. They shall be the “heavy-duty” stainless steel type 302, 304, or 316 and shall be listed by a third party such as U.L. or E.T.L.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General

1. Conductors shall be continuous from outlet to outlet and no splices shall be made except accessible in junction or outlet boxes. Wire connectors of insulating material or solderless pressure connectors, properly taped, shall be used for all splices in wiring, wherever possible.

2. Feeder conductors shall be color coded in accordance with the following schedule:

	480/227V 3 Phase	208/240V 3 Phase	120/240, Single Phase
Phase A	Brown	Black	Black
Phase B	Orange	Red	Red
Phase C	Yellow	Blue	
Neutral (Grounded)	White or Light Gray	White or Light Gray	White or Light Gray
3-Way Tracers			Blue
Grounding	Green	Green	Green
Remote Energized Control Conductors			Yellow
Standard Control			Red

3. Conductors shall be pulled into raceways in strict accordance with manufacturer's recommendations.

4. Ample slack conductors shall be allowed at each terminal point, and pull or junction box, to permit installation with ease and without crowding.

5. All conductors terminating at terminal blocks shall be identified with numbers and/or letters identical to circuit or control identification.

6. No conductors shall be drawn into conduits until all work which may cause wire or cable damage is completed. Wire pulling shall be accomplished utilizing machinery and accessories intended for the purpose.

7. All connections and splices shall be made in accordance with conductor manufacturer's recommendations, and as written herein.

8. If the size and number of conductors in a conduit on the Drawings is not shown, then it shall be assumed to be 4#12, 3/4" C.

9. An equipment grounding conductor, sized per NEC, shall be installed in each power, signaling, or instrumentation circuit whether indicated or not.

B. Feeders

1. Wire (up to and including #6 AWG) shall be factory color coded for each phase and neutral, with green used for the ground conductor. Larger conductors shall be identified with tape per Section 16075 requirements. As far as practical, all feeders shall be continuous from origin to panel termination without running splices in intermediate pull boxes.

C. Metal-Clad (MC) Cable Installation

1. MC cable shall only be used for lighting circuits accessible above suspended acoustical tile ceilings. A junction box fed with conduit shall be installed in the plenum space above each room for conversion from conduit to MC cable. The use of MC cable in walls, slabs, or to jump between rooms is prohibited. MC Cable shall not be installed in the wall cavity between face brick and block.

2. MC cable termination shall be prepared using a pre-engineered fitting designed specifically for the purpose.

D. Instrument Cable

1. Instrumentation cable must only be installed in dedicated conduits with other instrumentation cable. Installation with power conductors is prohibited.

2. Low level analog (less than 500 millivolt d-c): Use twisted pairs which may be cabled with other pairs carrying similar voltage levels. Foil wraps or equivalent shielding is required for each cable with the shield insulated from ground.

3. High level analog (greater than 500 millivolt d-c or 0-10 VDC or 4-20 mAdc): Use twisted pairs which may be cabled with other pairs carrying similar voltage levels and current levels less than 100 ma. Shielding is required.

4. All shields must be grounded at one point only as close as possible to the signal source.

5. A minimum separation of 12 inches between analog signal leads and a-c power leads should be maintained. For a-c power leads carrying 100 amps or greater, a 24 inch separation should be maintained. Parallel runs should be limited to less than 500 feet. Perpendicular runs may be as close as 6 inches.

3.02 FIELD TESTING

A. Megohm meter testing is required on circuits with #4 and larger conductors. Prior to energizing, check with 1000V megohm meter to determine insulation resistance levels to assure requirements are fulfilled. Minimum acceptable reading is 100 megohms held at a constant value for 15 seconds. A certified copy of megohm meter tests shall be submitted to the Engineer and included in the O&M manuals. Test results shall include ambient temperature and humidity at time of testing.

END OF SECTION

SECTION 16130

RACEWAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section of includes all raceways for accommodation of electrical conductors, communications conductors, sleeves for underground electrical installations, conduit stubs for future installations, fittings and accessories.

B. All raceways and fittings shall be painted to match existing or surrounding surfaces except in mechanical spaces.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

B. Division 9 – Paint

1.03 SUBMITTALS

A. Submit are required on all raceways and fittings in accordance with Section 16010 requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Tubular Raceways

1. Steel, Galvanized, Electric-Metallic-Tubing (EMT) - “VAW,” “Triangle,” “Allied Tube & Conduit Corp,” or equal.

2. Steel, Intermediate Metal Conduit (IMC, Electro-Galvanized, Rigid, Threaded - “Allied Tube and Conduit Corp.,” “Triangle,” “Wheatland Tube Co.,” or equal.

3. Plastic (PVC); Type 40 (or Schedule 40); Type 80 (or Schedule 80) (Heavy -Wall) - “Robin-Tech,” “Carlon,” or equal.

4. Aluminum, Rigid, Heavy-Wall, Threaded - “VAW,” “Alcoa,” “Reynolds,” or equal.

5. Steel, Galvanized, Rigid, Heavy-Wall, Threaded - “Wheatland Tube Co.,” “Triangle,” “Allied Tube & Conduit Corp.,” or equal.

6. Flexible Metal Conduit - “AFC,” “Alflex,” or equal.

7. Liquidtight Flexible Metal Conduit - “Carol Cable Co., Inc.,” “Superflex,” “OZ Gedney,” or equal.

8. Factory Coated Aluminum Conduit - Alumax “ALX-1", or equal.

B. Surface Metal raceways

1. “Iso-duct,” “Wiremold,” “Walker,” or equal.

C. Wireways

1. “Square-D,” “Hoffman,” or equal.

D. Raceway Fittings

1. Conduit fittings - “Crouse-Hinds,” “Appleton,” “OZ Gedney,” or equal.

2. Non-metallic conduit fittings - “Robin-Tech,” “Carlon,” “Scepter,” or equal.

3. Surface metal raceway fittings and fasteners shall be provided by the manufacturer of the raceway.

4. Flexible conduit fittings - “Raco,” “T & B,” “OZ Gedney,” or equal.

E. All raceways shall be marked with the manufacturer’s name or trademark as well as type of raceway and size. This marking shall appear at least once every 10 feet and shall be of sufficient durability to withstand the environment involved. All raceways shall be furnished and installed as outlines under Part 3 of this Specification.

2.02 MATERIALS

A. Aluminum Conduit

1. Aluminum conduit shall be extruded from alloy 6063 and shall be the rigid type, non-toxic, corrosion resistant, and non-staining. It shall be manufactured per UL standards as well as listed/labeled by same.

2. Fittings, boxes, and accessories used in conjunction with aluminum conduit shall be die cast, copper free type. They shall be resistant to both chemical and galvanic corrosion. All covers shall have neoprene gaskets.

3. Aluminum conduit proposed for concrete slab or underground applications shall be UL listed for the purpose and factory pre-coated. Corrosion-resistant taping is allowed for stubouts out of the ground.

B. Rigid Steel Conduit

1. Rigid steel conduit and fittings shall be of mild steel piping, galvanized inside and out, and shall conform to UL standards. The conduit and fittings hall be listed and labeled by UL as well. The galvanized coating of zinc shall be of uniform thickness applied by the hot-dipped process, and shall be applied also to the threads. It shall be further dipped in a chromic acid bath so as to chemically form a corrosion resistant protective coating of zinc chromate which has a characteristic yellow-green color. Each piece of conduit shall be straight, free from blisters and other defects, cut square, and taper reamed. It shall be delivered with plastic protectors on the threads.

C. Polyvinychloride (PVC) Conduit

1. PVC conduit and fittings shall be Schedule 80 heavy wall, as indicated in these Specifications manufactured to conform to UL standards. It shall be listed and labeled by UL. It shall have at least the same temperature rating as the conductor insulation. Expansion joints shall be used as recommended by the manufacturer in published literature. PVC systems shall be 90 degrees Celsius minimum UL rated, have a tensile strength of 7,000 psi @ 73.4 degrees Fahrenheit, flexural strength of 11,000 psi and compressive strength of 8,000 psi.

2. PVC conduit support clamps shall be non-metallic, non-corroding and specially designed for expansion and contraction. Adapters shall be provided for use with strut. Provide IPEX Scepter or equal.

D. Electrical Metallic Tubing (EMT)

1. EMT shall be high grade steel with an exterior galvanized coating of zinc applied uniformly by the electro-galvanized process. The interior surface shall be uniformly coated with aluminum lacquer or enamel. After galvanizing, it shall be dipped in a chromic acid bath to chemically form a protective coating of zinc chromate. The conduit shall conform to UL standards and be listed as well as labeled by UL.

E. Intermediate Metal Conduit

1. Intermediate metal conduit (IMC) shall be made of high performance steel and given extra strength by a special electro-weld forming process, and shall have a larger internal diameter than rigid steel conduit. IMC conduit shall be listed and labeled by UL. Exterior surfaces shall be hot-dip galvanized in the smaller sizes and electro-galvanized in the larger sizes

and then chromated. All threads shall be galvanized after cutting. The interior wall shall be coated with a silicone epoxy-ester lubricant. Each piece of conduit shall be straight, free from blisters and other defects, cut square, and taper reamed.

F. Surface Metal Raceway

1. Surface metal raceway shall be 2 piece type, base mounted with snap-on cover. Raceway installation shall be in accordance with manufacturer's instruction, using adapters and fittings specifically designed and manufactured for the raceway used.

G. Flexible Conduit

1. Flexible metallic conduit shall be constructed from flexibly or spirally wound elecro-galvanized steel. Connections shall be by means of galvanized malleable iron squeeze type fittings, or tomic twist-in type in sizes not exceeding 3/4 inch. Liquidtight conduit shall be light gray in color and have sealtight fittings, type UA. It shall be sunlight resistant and suitable for minimum temperature range of -22°F to 140°F. Where aluminum conduit is required below, the liquidtight fittings shall be constructed of copper-free aluminum. Where PVC conduit is required below, the liquid-tight shall be type NMUA non-metallic with non-metallic fittings.

H. Conduit Fittings

1. Rigid Steel and IMC Conduit Fittings

a. Standard threaded couplings, locknuts, bushings, and elbows made only of steel or malleable iron are acceptable. Integral retractable type IMC couplings are acceptable also.

b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.

c. Bushings: Metallic insulating type, consisting of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.

d. Erickson (union-type) couplings: Approved for use in concrete are permitted or use to complete a conduit run where conduit is installed in concrete.

e. Sealing fittings: Threaded cast iron type. Use continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, installed fittings in flush steel boxes with blank coverplates having the same finishes as that of other electrical plates in the room.

f. Compression fittings are NOT acceptable for use with Rigid conduit. All connections are required to be threaded.

2. Rigid Aluminum Conduit Fittings

a. Standard threaded locknuts and bushings shall be malleable iron, zinc-plated steel or aluminum alloy materials. Bushings/hubs shall have insulated throats. Elbows, couplings, hubs, and connectors shall be aluminum. Aluminum fittings containing more than 0.4 percent copper are prohibited.

b. Set screw or compression fittings: Not permitted for use with aluminum conduit.

3. Electrical Metallic Tubing Fittings

a. Only material of steel or malleable iron is acceptable.

b. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for all conduit sizes.

c. Set screw indent type connectors or couplings are prohibited.

d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of “pot metal” are prohibited.

4. Expansion and Deflection Couplings

a. Accommodate 1.9 cm (0.75 inch) deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.

b. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL, and the NEC code tables for ground conductors.

c. Watertight, seismically qualified, corrosion-resistant, threaded for and compatible with rigid or intermediate metal conduit.

d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material and stainless steel jacket clamps.

K. Corrosion-Protection Tape: The corrosion protection tape shall be Scotchrap 51 or equal with 20mil thickness PVC tape and high-tack adhesive. Degreasing and priming of the conduit is required prior to applying the corrosion-protection tape.

L. Duct Seal: Sealant shall be UL-listed electrical duct seal, Gardner Bender #1003 or equal. Caulk is not acceptable. Sealant shall be asbestos-free, permanently soft/non-hardening, FDA/USDA approved non-toxic, non-corrosive, non-irritant, and paintable. Temperature range shall be -30°F to 175°F, minimum.

PART 3 - EXECUTION

3.01 PREPARATION

A. Underground metallic conduits shall be degreased, primed, and wrapped with all-weather corrosion-resistant tape to 6" above finished grade. The tape shall be 50% overlapped such that there is an effective 2-layers of tape protecting the conduit.

3.02 INSTALLATION

A. Conduit

1. Surface metal raceways (SMR) shall be employed in all existing structures for wiring which must be exposed in the finished space.

2. Conduit shall not be installed in wall cavities between face brick and block. The only time this will be allowed is for serving an exterior receptacle or light fixture.

3. Underground raceways (conduit) shall be provided with steel sleeves where they pass over or under obstructions, such as: sidewalks; roadways; piping; etc.

4. All conduit shall have an insulated ground wire pulled to all equipment and receptacles.

5. All raceway runs are shown diagrammatically to outline the general routing of the raceway. The installation shall be made to avoid interference with pipes, ducts, structural members or other equipment. Should structural or other interference prevent the installation of the raceways, or setting of boxes, cabinets, or the electrical equipment, as indicated in the Drawings, deviations must be approved by the Engineer, and after approval, shall be made without additional charges and shown on the Record Drawings.

6. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases, with UL listed sealants only. Completely fill and seal clearances between raceways and openings with the fire stop material. See Section 15305 for complete fire stop requirements.

7. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.

8. No conduit shall be run exposed across roofs without first obtaining permission from the Engineer.

9. Conduit shall be installed underneath concrete slabs, not horizontally within the slab. See the detail on the Drawings.

10. No conduit shall be run exposed across floors.

11. Electrical conduits and/or equipment shall be rigidly supported. Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type.

12. Contractor shall provide all necessary supports in accordance with KBC Seismic requirements.

13. All conduit shall be installed in a first class workmanship manner. It shall be installed in horizontal and vertical runs in such a manner as to ensure against trouble from the collection of trapped condensation and shall be arranged so as to be devoid of traps wherever possible. Special care shall be used in assuring that exposed conduit runs are parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceilings. No open wiring is allowed.

14. Fittings or symmetrical bends shall be required wherever right angle turns are made in exposed work. Bends and offsets shall be avoided wherever possible, but where necessary, they shall be made with an approved conduit bending machine. All conduit joints shall be cut square, reamed smooth and drawn up tight, using couplings intended for the purpose.

15. Conduits shall be securely fastened to all sheet metal outlets, junction and pull boxes with double galvanized locknuts and insulating-grounding bushings as required by the NEC, except for penetrations in NEMA 4/4X areas which shall utilize Myers sealing hubs. Conduit crossings in insulating roof fill will require both conduits to be secured to the roof deck, and these crossings can only be made where the insulating fill is a minimum of 3 inches deep. Runs of exposed conduit shall be supported in accordance with the NEC using cast aluminum or malleable iron one hole pipe straps with spacers to provide an air space behind the conduit. Stainless steel minerallaac, one piece conduit clamps shall be acceptable where located such that building occupants are not in danger of inadvertent contact, since this type fitting has several sharp edges. In general terms, they may be considered in areas such as on or above ceilings, or high on walls. All conduit in walls and slabs shall be securely braced, capped (wooden plugs are prohibited), and fastened to the forms to prevent dislodgement during vibration and pouring of concrete.

16. During construction, all conduit work shall be protected to prevent lodgement of dirt, plaster or trash in conduits, fittings or boxes. Conduits which have been plugged shall be entirely freed of accumulations or be replaced. All conduits in floors or below grade shall be swabbed free of debris and moisture before wires are pulled. Crushed or deformed conduit shall not be permitted.

17. All open conduit work through floor slabs shall be made watertight by grouting around conduit. Provide coating where conduit comes in contact with all concrete.

18. Where IMC or GRS conduit penetrates a floor slab the conduit shall be protected with corrosion prevention tape to a point 6 inches above the penetration.

19. The final section of conduit connecting each motor or piece of utilization equipment subject to vibration shall be of the flexible type. Type “UA” shall be used in all process areas and in outdoor or wet locations. Flexible conduit to space heaters shall be long enough to allow swivel action.

20. All underground conduits entering a building shall be sealed against water/condensate entering around the conductors with duct seal.

21. In certain situations, conduit expansion joints shall be required to ensure against conduit and/or cable damage due to settling or thermal expansion and contraction. These expansion joints shall be required where required by the manufacturer or the Contract Drawings and shall be installed per manufacturer’s instructions.

22. Motor control centers, meter panels, computer panels, switchgear, etc., mounted in a building with a basement or pipe gallery below, shall have the conduit opening left in the slab sealed to prevent moisture, dust, etc., from entering the panel. The type of seal to be used shall be silicone elastomer foam, as manufactured by Dow-Corning, Chase-foam as manufactured by Chase Technology Corporation, T & B, or equal.

23. All conduit work in the finished space of each new structure shall be concealed except for conduits to lighting fixtures in buildings with precast roof slabs, or excepted as noted on the Contract Drawings. All conduit work below ground floor level in each structure shall be exposed. Conduits entering from underground into buildings shall be watertight through the wall, both inside and outside.

24. Where PVC conduit is installed, underground transition shall be made to GRS conduit at bends where wire pulling could cut conduit.

25. Aluminum conduit shall not be used underground, in chemical or chlorine storage/feed areas, or placed in concrete slabs, unless it is UL listed for the purpose and factory pre-coated.

26. Conduit stubs, for future use, extended through outside walls shall be capped with threaded pipe caps and coated to prevent corrosion. Stubs shall extend 5 feet beyond the walls from which they are stubbed unless otherwise indicated on the Contract Drawings.

27. All metal raceway systems shall be grounding conductive, solidly bonded throughout and grounded in accordance with NEC requirements and/or as noted on the Contract Drawings. In addition, all raceway systems shall be provided with separate grounding conductors.

28. Minimum conduit size shall be 3/4 inch.

29. Minimum burial depth shall be 30”

30. Wire pulling shall be facilitated by the use of a UL approved pulling compound in pulls over 30 feet in length or where there are 2 or more 90 degree bends. Only polypropylene, nylon, or manila pulling ropes will be permitted. Standard industry recognized wire pulling equipment shall be used.

31. All conduits entering and leaving exterior enclosures shall be sealed around the wires with duct seal. All underground conduits or exterior conduits shall be sealed with duct seal where they penetrate into an interior enclosure.

32. All conduits for emergency lighting systems shall be separate from other building power conduits.

33. Areas of use for each type of conduit:

	PVC	EMT	GRS	IMC	Aluminum	SMR
Exterior						
Underground	X		X	X		
Exposed			X	X	X	
Underneath Floor Slab	X		X	X		
Concealed in Wall/Above Ceiling		X	X	X	X	
Lab/Control/File/Bath/Filter Rooms						
Interior Exposed						X
Mechanical/Electrical Rooms						
Interior Exposed		X	X	X	X	
Other Rooms						
Interior Exposed					X	
NEMA 4X Non-Chemical Rooms						
Interior Exposed					X	
NEMA 4X Chemical Rooms						
Interior Exposed	X					

3.03 SERVICE ENTRANCE

A. Conductors and terminations for service entrances shall be furnished and installed by the Contractor. Voltage, phase, and number of wires shall be as shown on the Drawings. Clearances for overhead entrance wires shall be per Power Company, NEC, and NESC requirements.

B. Any details not shown on the Drawings or written in the Specifications pertaining to the service entrance shall be per power company requirements. It is the Contractor's responsibility to contact the utility prior to bidding and obtain any special requirements or costs they will be imposing. Those costs shall be included in the bid.

C. On underground service entrances from pad mounted transformers, the Contractor shall be responsible for furnishing and installing all primary, secondary, and metering conduits, as well as secondary service/metering conductors. The Contractor shall be responsible for furnishing pull wires in primary conduits for use by the power company. The Contractor shall be responsible for fabricating the required concrete pad that the transformer will be mounted on. The Contractor shall also mount the meter base furnished by the power company.

END OF SECTION

SECTION 16131

BOXES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Outlet/device boxes, pull boxes, junction boxes, and underground boxes shall be furnished and installed where indicated on the Contract Drawings, and\or as required by the work in accordance with the NEC.

B. Manholes shall be provided where indicated.

1.02 RELATED WORK

A. Section16010 – General Electrical Requirements

B. Section 16900 – Control Panels

1.03 SUBMITTALS

A. Submittals are required on all boxes and cabinets in accordance with Section 16010 requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Boxes - “Wiegmann,” “Appleton,” “Raco,” “Crouse-Hinds,” “Hoffman,” “Robroy Industries,” “Cloud Concrete Products,” “Carlon,” or equal.

B. Cabinets – “Hoffman,” “Wiegmann,” “Rittal,” or equal.

2.02 GENERAL

A. Outlet/Device Boxes:

1. Exposed Steel Conduit: Provide cast or malleable iron, zinc-electroplated outlet boxes finished with aluminum lacquer or enamel. Provide cast metal covers with neoprene gaskets for NEMA 4 areas and stamped steel covers for NEMA 12 and undesignated areas.

2. Exposed PVC Conduit: Provide PVC boxes and covers.

3. Exposed Aluminum Conduit: Provide copper free, cast aluminum boxes. Hardware shall be stainless steel.

4. Concealed Conduit: Provide galvanized coated flat-rolled sheet steel outlet wiring boxes of dimensions required by NEC. Boxes shall be flush mounted.

5. Exceptions to the above shall include NEMA 4X areas, where stainless or non-metallic boxes are required, and NEMA 6, 7, or 9 areas in which the boxes should be listed for use in the applicable environment.

B. Junction and Pull Boxes

1. Exposed Steel Conduit, up to 50 cubic inches: Provide cast or malleable iron, zinc-electroplated outlet boxes finished with aluminum lacquer or enamel. Boxes shall have drilled external, cast mounting extensions (bossed to provide at least 1/8" between back of box and mounting surface for drainage). Provide cast covers with neoprene gaskets.

2. Exposed PVC Conduit, up to 50 cubic inches: Provide PVC boxes and covers.

3. Exposed aluminum conduit, up to 50 cubic inches: Provide copper free, cast aluminum boxes. Hardware shall be stainless steel.

4. Exposed Conduit, Larger than 50 cubic inches: Provide sheet metal boxes with hinged covers and appropriate gaskets and NEMA rating. NEMA 1, 3R, 4 and 12 areas shall be painted steel or aluminum. NEMA 4X non-chemical areas shall be stainless type 316. NEMA 4X chemical areas shall be fiberglass. Padlock hasps shall be provided in areas accessible to the public.

5. Exceptions to the above shall include NEMA 6, 7, and 9 areas in which the boxes shall be listed for use in the applicable environment.

C. Underground junction or pull boxes or handholes shall be constructed of reinforced concrete cast-in-place or pre-fabricated as detailed on the Contract Drawings. Strength of manholes, handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete manholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48/A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a

flexural strength of at least 5,000 psi. Pullbox and handhole covers in sidewalks and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, AND ERECTION

A. General

1. Boxes shall be installed in the locations shown on the Contract Drawings. The Contractor shall study the general building plans in relation to the space surrounding each outlet, in order that his work may fit the other work required by these Specifications. When necessary, the Contractor shall relocate devices so that when fixtures or other fittings are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment.

2. All supports for outlet boxes shall be furnished and installed by the electrical trades.

B. Concealed Work

1. All outlet boxes shall be 4” x 4” standard galvanized steel type at least 1½ inches deep. Exceptions shall be noted on the Contract Drawings. Provide two inch single plaster ring for single devices in all CMU walls.

2. Standard deep type outlet boxes (concrete rings with appropriate covers) shall be used in floor slab construction so concealed conduits entering sides of boxes can clear reinforcing rods.

3. Outlet boxes for concealed telephone and signaling systems shall be the 4-inch square type, unless otherwise noted or required by the telephone company.

4. See details on Drawings for box requirements.

C. Interior Pull and Junction Boxes

1. Interior pull and junction boxes are not shown but shall be used as needed.

D. Manholes, Handholes, and Pullboxes - Exterior Underground

1. General

a. Manholes, handholes, and pull boxes for exterior underground work are shown on the Contract Drawings and are the minimum number required. Others may be added at the Contractor's option, but no extra pay shall be allowed. See detail on the Contract Drawings.

b. Manholes shall be constructed approximately where shown. The exact location of each manhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of manholes that are not indicated on the drawings shall be approved by the Engineer prior to construction. Manholes shall be the type noted on the Drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete manholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for manhole and handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of manhole covers shall be approximately 1/2 inch above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the manhole cover to existing grade level. All duct lines entering manholes must be installed on compact soil or otherwise supported when entering a manhole to prevent shear stress on the duct at the point of entrance to the manhole. Duct lines entering cast-in-place concrete manholes shall be cast in-place with the manhole. Duct lines entering precast concrete manholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast manholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the manhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

2. Electric Manholes

a. Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each manhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

3. Communications/Data/Instrumentation Manholes

a. The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each manhole. Each cable rack shall be provided with 2 cable hooks.

4. Handholes

a. Handholes shall be located approximately as shown. Handholes shall be of the type noted on the drawings and shall be constructed in accordance with the details shown.

5. Pullboxes

a. Pullbox tops shall be flush with sidewalks or curbs or placed 1/2 inch above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage," “Communications,” or “Instrumentation” as applicable and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

6. Ground Rods

a. A ground rod shall be installed at the manholes, handholes and pullboxes. Ground rods shall be driven into the earth before the manhole floor is poured so that approximately 4 inches of the ground rod will extend above the manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the manhole floor and a No. 1/0 AWG ground conductor brought into the manhole through a watertight sleeve in the manhole wall.

E. Openings in Electrical Boxes

1. All openings in electrical equipment, enclosures, cabinets, outlet and junction boxes shall be by means of welded bosses, standard knockouts, or shall be sawed, drilled, or punched with tools specially made for the purpose. The use of a cutting torch is prohibited. Unused openings shall be plugged per the NEC.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Wiring devices shall be provided where indicated on the Contract Drawings.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

B. Section 16130 - Boxes

1.03 SUBMITTALS

A. Submittals are required on all wiring devices in accordance with Section 16010.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. “Hubbell,” “Bryant,” “Eagle,” “General Electric,” “Wiremold,” “P&S,” “Leviton,” “Daniel Woodhead,” or equal.

2.02 EQUIPMENT

A. General

1. Equipment such as sample pumps shall be equipped with the proper cord and plug for receptacles.

2. Switch and receptacles for sump and sample pump motors shall be rated at 20 amps at 125 volts and shall be equipped with a manual motor starting switch in lieu of toggle switch, as specified elsewhere this Division.

B. Wiring Device Colors:

1. Interior Devices: Match existing color

2. Exterior Devices: Grey

C. Receptacles

1. General – All receptacles shall be heavy duty specification grade duplex receptacle, Nema 5-20R, 20A, 125V, 3-wire. Provide weatherproof-in-use cover where indicated on the Drawings. Duplex outlet (interior) - “Hubbell” catalog series 5362, or equal.

2. Single outlet – Hubbell series 5361 single receptacle, or equal.

3. Special purpose outlet - Per equipment requirements.

4. Ground fault interrupting receptacles shall be required where shown on the Contract Drawings, and shall be indicated by the abbreviation “GFI” beside the circuit symbol on the Contract Drawings. They shall be rated 20 amps (125 volts) and shall be of the duplex, feed through type, capable of protecting all downstream receptacles on the same circuit. They shall be UL listed and shall comply with UL 943 and interrupt the current between 4-6 milliamps of ground fault leakage. Appropriate plates shall be furnished and installed. The 20 ampere rating shall apply not only to device internals but to the faceplate as well. Receptacle shall be Hubbell GFI 5352, or equal.

D. Plates and Covers

1. Furnish and install plates of the appropriate type and size for all wiring and control devices, signal and telephone outlets.

2. All plates on surface mounted boxes shall be of 302 stainless steel (nonmagnetic) with rounded or beveled edges, except in NEMA 3R and 4/4X areas, then weatherproof-in-use covers shall be installed. All plates on flush mounted boxes shall be 302 stainless steel. All device plate screws shall be stainless steel with countersunk heads. Screwheads shall be colored to match the plates. Plates shall be installed vertically and with an alignment tolerance of 1/16 inch. Device plates shall be of the one-piece type, of suitable shape for the devices to be covered. Plates shall have a smooth finish with no crevices to collect dirt. Oversize plates are not acceptable.

3. Covers for boxes serving equipment where flexible conduit is to be tapped into cover plates shall be sheet metal drilled for conduit. Gaskets shall be required as well as all special adapters for mounting.

4. Weatherproof covers shall be Hubbell WP series, Thomas and Betts 2CKG, or equal. They shall be weatherproof-in-use with cast aluminum construction. Mounting screws shall be stainless. Protection shall be Nema 3R.

E. Wall Switches (Tumbler Type)

1. General – Switches shall be industrial grades, 120/277VAC, 20A Single pole - “Hubbell” cat. series 1221, or equal.

2. Single pole (exterior) - “Hubbell” cat. no. 1222-gray, or equal, and Bryant 7420 or equal plate.

3. Switch and pilot light (interior) - “Hubbell” cat. no. 1221-IL (with lighted switch handle), or equal.

4. Switch and pilot light (exterior) - “Hubbell” cat. no. 1221-PL, or equal.

5. 3-way switches (interior) - “Hubbell” cat. no. 1223, or equal.

6. Double-pole (interior) - “Hubbell” cat. no. 1222, or equal.

7. 4-way switches (interior) - “Hubbell” cat. no. 1224, or equal.

8. Weatherproof switch covers shall be Hubbell 7420 series, or equal, with stainless mounting screws, cast aluminum construction and wet location rating.

F. Break-Glass Emergency Switch

1. Surface Mount NEMA 4/4X – Provide Allen-Bradley Bulletin 800T series or equal red push-button station with two NO and two NC contacts rated 120V minimum. The contacts shall operate when the glass is broken with the attached accessory tool. A “STOP” legend plate shall be included. Switch must be field-labeled with appropriate label to indicate what system it controls.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Wall Switches

1. Wall switches shall be mounted at a height as indicated on the Drawings, unless otherwise noted on the Contract Drawings.

B. Receptacles

1. Outlets shall be located as shown on the Contract Drawings. Where located in special interior finishes, they shall be properly centered. Boxes shall be of the type noted and accepted for the specific installation.

2. Furnish and install receptacle circuits where called for on the Contract Drawings and/or by these Specifications. Circuits shall be installed in conduit from panel to receptacle, with flush mounted boxes except as noted on the Contract Drawings.

3. Receptacles and lighting circuits shall not be combined on the same overcurrent device. For runs over 75 feet or for 30 amp receptacles, minimum wire size shall be AWG No. 10.

4. Receptacles for specific devices (e.g., air conditioner), shall be rated at the correct voltage and amperage for that unit.

5. The minimum free length of conductor at each box for the connection of a fixture, switch or receptacle shall be 8 inches. All connections shall be made mechanically and electrically secure.

6. Mounting heights shall be as indicated on the Drawings. Utilize medium mounting height for receptacles in locations subject to flooding.

7. Receptacles over workbenches or countertops or at medium or high mountings shall be mounted so that the grounding slot is below the neutral and hot. All other receptacles shall be mounted with the grounding slot above the neutral and hot.

END OF SECTION

SECTION 16150

WIRE CONNECTIONS AND CONNECTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Wire connection and connecting devices shall be as herein specified.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Submittals are required in accordance with Section 16010.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Connectors, Lugs, etc. - “T & B”, “Anderson”, “Burndy”, or equal.

B. Ties and Servings - “T & B”, “Panduit”, or equal.

C. Termination and splice connectors - “3M Scotchlok”, “Anderson”, “T & B”, “Burndy”, or equal.

2.02 MATERIALS

A. Wire Splicing and Terminations (600 Volts and Below)

1. Electrical Terminal and Splice Connectors (#22 - #4 AWG)

a. Terminals and splice connectors from #22 - #4 AWG shall be compression types with barrels to provide maximum conductor contact and tensile strength. Performance, construction, and materials shall be in conformance with UL standards for wire connectors and rated for 600 volts and 105 degrees Celsius.

b. Connectors shall be manufactured from high conductivity copper and entirely tin plated. Terminal barrels shall be serrated on the inside surface and have a chamfered conductor entry. Terminals shall

have funnel entry construction to prevent strand fold-back. All barrels shall be brazed seam or seamless construction.

c. Spade type terminals shall be sized for the appropriate stud and shall be locking type that snap firmly onto studs with a close fit for maximum retention. Spade type terminals shall be insulated with an insulation suitable for maintaining a high dielectric strength when crimped and be made form nylon, PVC, or equal.

2. Electrical Lugs and Connectors (#6 AWG - 1000 Kcmil)

a. Lugs and splice connectors from #6 AWG - 1000 Kcmil shall be compression types with barrels to provide maximum conductor contact and tensile strength. They shall be manufactured from high conductivity copper and entirely tin plated. They shall be crimped with standard industry tooling. The lugs and connectors must have a current carrying capacity equal to the conductors for which they are rated and must also meet all UL requirements. All lugs above 4/0 AWG shall be 2 hole lugs with NEMA spacing. The lugs shall be rated for operation through 35 KV. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

3. Twist-on Wire Connectors (#22 AWG - #10 AWG)

a. All twist-on wire connectors must have a corrosion resistant spring that is free to expand within a steel jacket. The steel jacket must be insulated with a flexible vinyl jacket capable of withstanding 105 degrees Celsius ambient temperatures and of sufficient length to cover wires that are inadvertently overstripped.

b. Each connector size must be listed by UL for the intended purpose and color coded to assure that the proper size is used on the wire combinations to be spliced. The connectors must be compatible with all common rubber and thermoplastic wire insulations.

4. Solderless/re-usable lugs shall be used only when furnished with equipment such as control panels, furnished by others, where specification of compression type lugs is beyond the Contractor’s control. In the event their use is necessary, the Contractor shall be responsible for assuring that they are manufactured to NEMA standards, with proper number and spacing of holes and set screws.

PART 3 - EXECUTION

3.01 INSTALLATION, APPLICATION, & ERECTION

A. Insulation of Splices and Connections

1. Connections/splices with a smooth even contour shall be insulated with a conformable 7 mil thick vinyl plastic insulating tape which can be applied under all weather conditions and is designed to perform in a continuous temperature environment up to 105 degrees Celsius. The tape shall have excellent resistance to abrasion, moisture, alkalies, acids, corrosion, and varying weather conditions (including sunlight). The tape shall be equal to Scotch 33+ and shall be applied in conformance with manufacturer's recommendations. In addition, it shall be applied in successive half-lapped layers with sufficient tension to reduce its width to 5/8 of its original width. The last inch of the wrap shall not be stretched.

2. Connections/splices with irregular shapes or sharp edges protruding shall be first wrapped with 30 mil rubber tape to smooth the contour of the joint before being insulated with 33+ insulating tape specified in the previous paragraph. The rubber tape shall be high voltage (69 KV) corona-resistant based on self-fusing ethylene propylene rubber and be capable of operation at 130 degrees Celsius under emergency conditions. The tape must be capable of being applied in either the stretched or unstretched condition without any loss in either physical or electrical properties. The tape must not split, crack, slip, or flag when exposed to various environments. The tape must be compatible with all synthetic cable insulations. The tape must have a dissipation factor of less than 5 percent at 130 degrees Celsius, be non-vulcanizing, and have a shelf life of a least 5 years. The rubber tape shall be applied in successive, half-lapped wound layers and shall be highly elongated to eliminate voids. Other manufacturer's recommendations on installation shall be adhered to. The rubber tape shall be equal to Scotch 23 or 130C electrical splicing tape.

3. Splices made in wet or damp locations shall be made submersible and watertight with special kits made for the application and compatible with type of cables employed.

B. Connection Make-up

1. Connections of lugs to bus bars, etc., shall be made up with corrosion resistant steel bolts having non-magnetic properties with matching nuts, and shall utilize a Belleville spring washer (stainless steel) to maintain connection integrity. Connections shall be torqued to the proper limits. Prior to bolting up the connection, electrical joint compound shall be brushed on the contact faces of the electrical joint.

2. All motor lead connections shall be made up to match the type of lead furnished on the motor. If the lead is not lugged, then twist-on wire connectors may be used. To prevent possible vibration problems, twist-on connectors shall be taped after installation.

3. All lugged motor lead connections (excluding motors over 200 horse-power) shall be made up using ring tongue compression lugs with proper size stainless steel nuts and bolts. Belleville type spring shall be used to maintain tension on the connections. The connections shall then be insulated using the procedure described for irregular shapes, utilizing rubber tape in conjunction with vinyl electrical tape.

4. At the time of final inspection, the Engineer may request the Contractor to disassemble 3 randomly selected motor lead connections in the Engineer's presence, to assure conformance with these Specifications.

5. The Contractor shall include all necessary tools, materials, and labor in his bid for disassembly of the connections and for remaking them with new insulating materials after inspection.

END OF SECTION

SECTION 16220

MOTORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Motors are to be furnished with driven equipment except where otherwise noted on the Contract Drawings or elsewhere in this Division of the Specifications. All motors shall conform to the following Specifications and any special requirements of the driven equipment. Special requirements of the driven equipment shall take precedence over these Specifications should a discrepancy occur. Starting torque and slip ratings shall conform to the requirements of the driven equipment.

B. Polyphase motors shall be of the squirrel cage induction type and single phase of the capacitor start-induction run type except as otherwise noted. Conduit boxes shall be tapped for the size conduit shown on the Contract Drawings.

C. All motors shall be manufactured and installed in accordance with applicable NEMA standards and NEC provisions, latest revisions.

1.02 RELATED WORK

A. Division 11

B. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Submittals are required in accordance with Section 16010 requirements.

1.04 DELIVERY, STORAGE, & HANDLING

A. All electrical motors shall be protected against the accumulation of moisture, dust and debris and physical damage during the course of installation of the job.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Motors - “General Electric”, “Westinghouse”, “U.S. Motors”, “Gould Century”, “Lincoln”, “Baldor”, “Marathon”, “Reliance”, “Magnatek”, “Siemens”, or equal.

2.02 EQUIPMENT

A. Motors 200 Horsepower and Under for Service Under 600 Volts

1. Ratings and Electrical Characteristics

a. Time: All motors shall be rated for continuous duty.

b. Temperature: Based on NEMA standards for a maximum ambient temperature of 40 degrees Celsius and an altitude of 3,300 feet or less, according to service factor and insulation class employed.

c. Voltage: All single phase motors shall be rated 115/208/230 volts and all polyphase motors 230/460 volts. Submersible polyphase motors to be operated at 460 volts may take exception to the dual voltage requirement. All motors shall be capable of normal operation at balanced voltages in the range of ±10 percent from rated winding voltage.

d. Frequency: All a-c motors shall be rated for 60 Hz. operation. All motors shall be capable of normal operation at frequencies 5 percent above or below the nominal rating of 60 Hz.

e. Horsepower: Horsepower of the motors shall be as given in the Specification Division on the driven equipment or as shown on the Contract Drawings. Submersible motors shall be allowed to be furnished even though the horsepower rating may not be in accordance with standard NEMA assignments. In many cases, the horsepower specified is a minimum requirement and certain alternate manufacturers may require larger horsepower motors. The larger motor shall be furnished at no extra cost to the Owner.

f. Locked Rotor Current: Locked rotor current shall be in accordance with NEMA standards.

g. Efficiency and Power Factor: Efficiency and power factor shall be given consideration during Shop Drawing review. The ratings at full, ¾, and ½ load shall be compared to similar motors manufactured by acceptable suppliers listed in these Specifications. Excessive variation shall be considered grounds for rejection.

h. Speed: Synchronous speed of motors shall correspond to standard NEMA ratings. Actual speed shall be as given in the Specification Division on the driven equipment. Slip shall not exceed 5 percent at full load.

i. Service Factor: The service factor shall be 1.15 unless requirements of the driven load necessitate a higher service factor.

j. Insulation Class: Insulation shall be NEMA Class B, except as otherwise noted. Submersible motors shall be Class F, and motors to be operated at variable speed shall be Class F. Class F insulated motors shall operate at a Class B rise at nameplate horsepower loading.

k. Design Level: Motors shall be NEMA design B, except as otherwise noted.

l. Enclosure: Motors for process equipment 2 HP and smaller shall be totally enclosed. All motors for process equipment larger than 2 HP shall be TEFC (totally enclosed fan cooled), suitable for use indoors or outdoors, except as otherwise noted. Totally enclosed non-ventilated (or air-over) motors may be used for ventilators and other auxiliary equipment that by virtue of the load are provided with more than adequate ventilation. ODP (open dripproof) motors may be used for ventilators where the motor is outside the air stream yet still protected from the weather. Division 15 of the Specifications and the HVAC Contract Drawings will detail the type of enclosure required for ventilators. Submersible motors shall be air or oil filled and of watertight construction. Motors used in classified atmospheres shall be properly rated for that hazard. Motors for potable water wells shall be water-filled/lubricated.

m. Frame Size: Frame designations shall be in accordance with NEMA standards.

n. Winding Overtemperature Sensors: All motors 15 to 200 HP shall be provided with motor winding thermostats. The devices shall be hermetically sealed, snap-acting thermal switches, actuated by a thermally responsive bi-metallic disk. A minimum of 1 per phase is required, with switches wired into the control circuit of the starter to provide de-energization should overheating threaten. All submersible motors shall be equipped with motor winding thermostats regardless of size. Also all motors 0-200 HP operated by adjustable frequency drives shall have motor winding thermostats.

o. All submersible pump/motor assemblies shall be equipped to detect presence of moisture and alarm at the controller.

2. Mechanical Characteristics

a. Integral Horsepower Motor Construction

(1) Motor frames for horizontal motors shall be cast iron, heavy fabricated steel, or cast aluminum (alloy 356 or 360). A steel insert ring shall be set into the aluminum alloy endshield when

cast to minimize wear of the bearing support. Aluminum alloy motors shall not be used in areas where exposed to chlorine gas.

(2) Motor frames for vertical motors shall be cast iron, heavy fabricated steel, or extruded aluminum (alloy 6063-T4 or 6063-T6). Endshields for vertical motors must be cast iron.

(3) If an aluminum frame is used, the endshields and/or all other steel hardware must be plated with zinc or cadmium and coated with grease before assembly to minimize the galvanic action between the steel and aluminum.

(4) Motor frames and endshields shall be of such design and proportions as to hold all motor components rigidly in proper position and provide adequate protection for the type enclosure employed. Lifting lugs of all motors shall conform to NEMA standards.

(5) Windings shall be random or form wound, adequately insulated and securely braced to resist failure due to electrical stresses and vibration. If the windings are aluminum, there shall be a cold welded aluminum-copper transition joint at the termination of the windings to permit the use of standard copper to copper connection techniques by the electrician and to prevent galvanic action between the copper power wires and the aluminum windings.

(6) The motor shaft shall be made of high grade machine steel or steel forging of size and design adequate to withstand the load stresses normally encountered in motors of that particular rating. Bearing journals shall be ground and polished.

(7) Rotors shall be made from high grade steel laminations adequately fastened together and to the shaft. Rotor cage windings may be cast aluminum of bar type construction with brazed end rings.

(8) Integral horsepower motors shall be equipped with cone, roller, or ball bearings made to AFBMA standards, Grade 1 and shall be of ample capacity for the motor ratings. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication (ten years normal operation without lubrication), but facilities shall be provided for adding new lubricant and draining out old lubricant without motor disassembly. The bearing housing shall have long, tight running fits or rotating seals to protect

against the entrance of foreign matter into the bearings or leakage of lubricant out of the bearing cavity.

(9) See the specification division relating to each piece of motor driven equipment for additional motor requirements to those listed above.

b. Fractional Horsepower Motor Construction

(1) Motor and shell shall be rigid welded steel designed to maintain accurate alignment of motor components and provide adequate protection. End shields shall be reinforced, lightweight, die cast aluminum. Windings shall be of varnish insulated wire with slot insulation of polyester film and baked on bonding treatment to make the stator winding strongly resistant to heat, aging, moisture, electrical stresses, and other hazards. Motor shafts shall be made from high grade, cold rolled, shaft steel with drive shaft extensions carefully machined to standard NEMA dimensions for shaft coupled drive connection. Bearings shall be carefully selected precision ball bearings with extra quality, long life grease and large reservoir providing 10 years normal operation without relubrication, AFBMA Grade 1.

c. Submersible Motor Construction

(1) See Equipment Specifications.

3. Tests, Nameplates, and Shop Drawings

a. Tests

(1) Tests shall be required on integral horsepower motors only. A factory certified test report of “electrically duplicate motors previously tested” shall be supplied on all motors under 200 horsepower. The test shall be certified by the factory and shall contain a statement to the effect that complete tests affirm the guaranteed characteristics published in the manufacturer’s catalogs or descriptive literature.

(2) Tests will be in accordance with IEEE test procedures.

b. Nameplates

(1) Each motor shall have a permanently affixed nameplate of brass, stainless steel, or other metal of durability and corrosion resistance. The data contained on the nameplate shall be in accordance with NEMA standards.

(2) Submersible pump motors and other motors in difficult-to-access locations shall be furnished with a spare nameplate for mounting inside the MCC or starter enclosure.

c. Shop Drawings

(1) Shop Drawings shall consist of motor dimensions, nameplate data from each motor and tests as outlined above. Also included shall be efficiency and power factor at 100, 75, and 50 percent load. Operation, maintenance, and lubrication information (including bearing catalog numbers) shall be submitted with Shop Drawings for review.

4. Efficiency Requirements

a. NEMA premium efficiency or IEC 60034-30 Level IE3 efficiency levels shall be the minimum acceptable levels as follows.

Minimum Efficiency Requirements (%)			
	Nominal 1200 RPM	Nominal 1800 RPM	Nominal 3600 RPM
1	82.5	85.5	77.0
1.5	87.5	86.5	84.0
2	88.5	86.5	85.5
3	89.5	89.5	86.5
5	89.5	89.5	88.5
7.5	91.0	91.7	89.5
10	91.0	91.7	90.1
15	91.7	92.4	91.0
20	91.7	93.0	91.0
25	93.0	93.6	91.7
30	93.0	93.6	91.7
40	94.1	94.1	92.4
50	94.1	94.5	93.0
60	94.5	95.0	93.6
75	94.5	95.4	93.6
100	95.0	95.4	94.1
125	95.0	95.4	95.0
150	95.8	95.8	95.0
200	95.8	96.2	95.4

B. Winding Heaters – Required for motors over 15 HP where located outside or in unconditioned space.

1. Heaters shall be wrapped around the winding end turns. They shall be designated for operation on 120 volts, 1-phase, 60 Hz, alternating current and of sufficient capacity or wattage that, when energized, they will hold the temperature of the motor windings approximately 10 degrees C above the ambient temperature. They shall be designed for continuous operation and to withstand at least 10 percent overvoltage continuously. The rate of heat dissipation shall be uniform throughout the effective length of the heater. Heaters installed around the winding end turns shall consist of the required turns of heating cable wrapped around the end turns and secured in place before the winding is impregnated.

    a. Heating Element: Heating element shall conform to the requirements of ASTM B344 for an 80 percent nickel and 20 percent chromium alloy.

    b. Sheath: Sheath shall be of a corrosion-resisting, nonoxidizing metal and shall have a wall thickness not less than 0.025 inch.

    c. Insulation: Insulation shall be a granular mineral refractory material, highly resistant to heat, and shall have a minimum specific resistance of 1,000 megohms per inch cubed at 535 degrees C or 1,000 degrees F. Insulation for the heating cable (winding wraparound type) type heaters shall be suitable for a conductor temperature of 180 degrees C or 356 degrees F.

    d. Terminals: The terminal box shall be readily accessible so that winding heaters can be energized while motors are in storage.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Installation of motors shall comply with motor manufacturer instruction’s as well as applicable NEMA recommendations and requirements of the driven equipment OEM (original equipment manufacturer).

B. Motors shall be aligned to acceptable tolerances and shall not vibrate excessively.

C. Motors shall not be energized until they have been accepted by the OEM start up personnel.

END OF SECTION

SECTION 16235

AUTOMATIC TRANSFER SWITCH

PART 1- GENERAL

1.01 SCOPE OF WORK

A. This Specification covers the provision of the automatic transfer switch.

B. All materials equipment and parts comprising the units specified herein, shall be new and unused, of current manufacture and of the highest grade. All equipment shall be free from all defects or imperfections.

1.02 SUBMITTALS

A. The submittal shall include complete wiring schematics and interconnection diagrams identifying by terminal number each required interconnection. Emergency shutoff pushbuttons, engine control panel, etc. The submittal shall also contain complete descriptive literature on every piece of equipment.

B. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature. For example: Device boxes – Styles shall be listed as: For masonry walls, for electrical devices, for ceiling mounted light fixtures, etc

1.03 GUARANTEE

A. Warranty - Equipment furnished under this section shall be guaranteed against defective parts or workmanship under terms of the manufacturer's and dealer's standard warranty, but in no case less than two (2) years from date of initial startup of the system and shall include labor and travel time for repairs at the jobsite for the entire warranty period. Prorating of any item is not acceptable.

1.04 TESTING

A. Automatic Transfer Switch

1. After fabrication of the transfer switches in the manufacturer’s plant, a high potential test shall be conducted in accordance with NEMA’s requirements for 480 volts operation. In addition, an operating test shall be simulated to verify that all of the equipment performs as described above. A certified test report shall be furnished by the manufacturer to show that each

transfer switch meets all requirements of these Specifications and that the operational requirements have been met.

1.05 ON-SITE TESTING

A. Automatic Transfer Switch

1. Upon completion of installation and after building circuitry has been energized with the normal power source, the contractor shall test the system including the transfer switches to demonstrate operation and compliance with specification requirements. Any deviations from the specification requirements shall be corrected, then the system shall be re-tested to verify conformance.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The transfer switch shall be manufactured by Russelectric, Eaton, Asco, or equal.

2.02 TRANSFER SWITCH CHARACTERISTICS

A. Automatic Transfer Switch

1. Provide one new automatic transfer switch, rated as indicated on the Drawings. The switch shall be capable of switching all classes of loads and shall be rated for continuous duty, when installed in a non-ventilated enclosure. The switch shall be mounted in a NEMA 1 freestanding enclosure, be constructed of 12 gauge steel, and conform to UL 50 standards.

2. The complete switch assembly shall be listed under UL-1008 for use on emergency systems.

3. The transfer switch shall be double throw, actuated by two electrical operators momentarily energized and connected to the transfer mechanism by a simple over-center linkage to provide “quick-make”, “quick-break” operation of the contacts when operated electrically or manually. The switch shall provide a time delay in the “Off” position between the opening of the closed contacts and the closing of the open contacts to allow for the demagnetizing of motor and transformer loads. The time delay shall be a minimum of 25 Hz., and shall be adjustable 0-2 minutes. In-phase monitor systems are not acceptable.

4. The transfer switch shall be capable of transferring successfully in either direction with 70% of rated voltage applied to the switch terminals.

5. The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Designs relying on electrical interlocks only are not acceptable. Main contacts shall be mechanically locked in position in both the normal and emergency positions without the use of hooks, latches, magnets, or springs, and shall be silver tungsten alloy. Separate arcing contacts, with magnetic blowouts, shall be provided on all transfer switches. Interlocked molded case circuit breakers or contact are not acceptable.

6. The transfer switch shall be equipped with a safe manual operator designed to prevent injury to operating personnel. The manual operator shall provided the same contact-to-contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. Manual operation shall be safe even if the electrical operator becomes energized and shall not require any prior disconnection of operators or control wiring. Safe manual transfer shall be possible under all load conditions, energized or non-energized.

7. All control wire shall be terminated with locking spade slips and sleeve markers for positive connections and permanent identification. All wiring shall be 600 volt SIS flame-retardant type.

B. Automatic Transfer Switch 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 controller shall include an Ethernet port with Modbus TCP or Ethernet/IP protocol.

4. The controller shall have password protection required to limit access to qualified and authorized personnel.

5. The controller shall included a 20 character, LCD display, with a keypad, which allows access to the systems.

6. The controller shall included three phase over/under volt, over/under frequency, phase sequence detection and phase differential monitoring on both normal and emergency sources.

7. The controller shall be capable of storing the following records in memory for access either locally or remotely:

   a) Number of hours transfer switch is in the emergency position (total since record reset).

   b) Number of hours emergency power is available (total since record reset).

   c) Total transfer in either direction (total singe 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.

C. Sequence of Operation

1. When the voltage on any phase of the normal source drops below 80% or increases to 120% or frequency drops below 90%, or increase to 110%, or 20% voltage differential between phases occurs, after a programmable time delay period of 0-9999 seconds factory set at 3 seconds to allow for momentary dips, the engine starting contact shall close to start the generating plant.

2. The transfer switch shall transfer to emergency when the generating plant has reached specified voltage and frequency on all phases.

3. After restoration of normal power on all phases to a preset value of at least 90% to 110% of rated voltage, and at least 95% to 105% of rated frequency, and voltage differential is below 20%, an adjustable time delay period of 0-9999 seconds (factory set at 300 seconds) shall delay retransfer to allow stabilization of normal power. If the emergency power source shall fail during this time delay period, the switch shall automatically return to the normal source.

4. After retransfer to normal, the engine generator shall be allowed to operate at no load for a programmable period of 0-9999 seconds, factory set at 300 seconds.

D. Automatic Transfer Switch 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 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.

3. Time delay on override of momentary normal source power outages (delays engine start signal and transfer switch operation). Programmable 0-9999 seconds. Factory set at 3 seconds, if not otherwise specified.

4. Time delay on retransfer to normal, programmable 0-9999 seconds, factory set at 300 seconds if not otherwise specified, 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 emergency, 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 remote type load test switch shall be included to simulate a normal power failure, remote switch initiated.

8. A time delay bypass on retransfer to normal shall be included. keypad initiated.

9. Contact, rated 10 Amps 30 volts DC to close on failure or normal source to initiate engine starting.

10. Contact, rated 10 Amps 30 volts DC , to open on failure of normal source for customer functions.

11. Light emitting diodes shall be mounted on the microprocessor panel to indicate: switch is in normal position, switch is in emergency position and controller is running.

12. 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 generating plant programmable in one minute increments, Also include selection of either “no load” (switch will not transfer) or “load” (switch will transfer) exercise period. Keypad initiated.

13. Provision to select either “no commit” or “commit” to transfer operation in the event of a normal power failure shall be included. In the “no commit position,” the load will transfer to the emergency position unless normal power returns before the emergency source has reach 90% of it’s rated values (switch will remain in normal). In the “commit position” the load will transfer to the emergency position after any normal power failure. Keypad initiated.

14. Two auxiliary contacts rated 15 amp, 120 volts AC shall be mounted on the main shaft, one closed on normal, the other closed on emergency. Both contacts will be wired to a terminal strip for ease of customer connections.

15. A three phase digital LCD voltage readout, with 1% accuracy shall display all three separate phase to phase voltages simultaneously, for both the normal and emergency source.

16. A digital LCD frequency readout with 1% accuracy shall display frequency for both normal and emergency source.

17. An LCD readout shall display normal source and emergency source availability.

E. Testing and Approval

1. As a condition for approval, the manufacturer of the automatic transfer switches shall verify that his switches are listed by Underwriters Laboratories, Inc., Standard UL-1008 with 3 cycle short circuit closing and withstand rating of 65kA minimum.

2. During the 3 cycle closing and withstand tests, there shall be no contact welding or damage. The 3 cycle test shall be performed without the use of current limiting fuses, and oscillograph traces across the main contacts shall be furnished to verify that contact separation has not occurred, and there is contact continuity across all phases after completion of testing. Test procedures shall be in accordance with UL-1008, and testing shall be certified by Underwriters’ Laboratories Inc.

3. When conducting temperature rise tests to UL-1008, the manufacture shall include post-endurance temperature rise test to verify the ability to the transfer switch to carry full rated current after

completing the overload and endurance tests.

4. Manufacturer shall provide copies of test reports upon request.

PART 3 - EXECUTION

3.01 AUTOMATIC TRANSFER SWITCH INSTALLATION

A. Install the automatic transfer switch in accordance with equipment manufacturer's written instructions and recognized industry practices to ensure that system equipment complies with requirements of NEC.

B. Coordinate with other electrical work, including cables, wires, raceways, electrical boxes and fittings as appropriate.

C. Provide equipment grounding connections, sufficiently tight to assure permanent and effective ground.

END OF SECTION

SECTION 16280

SURGE PROTECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide transient voltage surge suppressors (TVSS) for distribution equipment (switchboards, motor control centers, and panelboards) as indicated on the Drawings and as specified herein.

B. Provide transient voltage surge suppressors and other surge protective devices (SPDs) for all systems and equipment as indicated on the Drawings, as specified herein, and as specified in individual Specification sections in Division 16 and 17.

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

B. Section 16670 - Lightning Protection Systems

C. Section 16442 - Panelboards

D. Section 17100 – Instrumentation

E. Section 17200 – SCADA Hardware

1.03 SUBMITTALS

A. Submit product data on all surge protective equipment. Catalog data shall include all information necessary to prove compliance with this Specification. Proposed part numbers and options shall be flagged, and non-applicable equipment shall be crossed out. Provide a table of each suppressor location. Installation instructions and drawings shall also be included with the shop drawing submittal.

B. Clearly note all options being submitted with underlines in product literature. Provide a list for each model number of suppressor and corresponding service used.

C. TVSS specifications shall include UL 1449 surge suppression ratings.

D. Submit operation and maintenance information on all surge protective equipment.

1.04 REFERENCES

A. ASTM A 123/A 123M (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

B. ASTM A 153/A 153M (2005) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

C. IEEE C62.11 (latest version) Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1kV)

D. NEMA LA 1 (latest version) Standard for Surge Arresters

E. NFPA 70 (latest version) - National Electrical Code

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Switchboard, MCC, and Panelboard Transient Voltage Surge Suppressors – Eaton, Square D, GE, Siemens, or equal.

B. Equipment and Instrumentation SPDs - “Phoenix Contact,” “Eaton,” “ABB,” “Transtector,” or equal.

2.02 GENERAL REQUIREMENTS

A. Surge protection equipment operating temperature shall be –20°F to 125°F, minimum range.

B. TVSS equipment shall be UL 1449 listed.

2.03 DISTRIBUTION EQUIPMENT SPD/TVSS

A. The TVSS shall be suitable for application in category C3 environments as described in ANSI/IEEE C62.41. The TVSS shall be of parallel design and provide protection, line to ground, neutral to ground, and line to neutral for wye or delta distribution systems.

The TVSS shall be compatible with the indicated electrical system, voltage, current and distribution configuration.

B. Non-listed manufacturers shall submit oscillographs and/or computer generated graphs from compatible smartscopes, which demonstrate TVSS clamping voltage values when tested to category C3 (per ANSI/IEE C62.45) 6kV 1.2x50 microseconds and 10kA 8x20 microseconds test waveshapes, in all specified suppression modes.

C. TVSS shall comply with ANSI/IEEE C62.1, C62.41, and C62.45. The TVSS shall be capable of surviving 1,000 sequential category C3 surges without failure following IEEE test procedures established in C62.45.

D. TVSS shall have 200kA short circuit current ratings. TVSS shall have thermal disconnects to protect against overvoltage conditions.

E. The TVSS shall use redundant LED indicators that provide indication of suppression failure.

F. The TVSS maximum continuous operating voltage (MCOV) shall be capable of sustaining 110 percent of the nominal RMS voltage continuously without degradation.

G. The TVSS shall use only solid state clamping components to limit the surge voltage.

H. Service entrance TVSS shall have surge current capacity of 80,000 amps minimum per mode. Distribution Panelboard TVSS shall have a surge current capacity of 40,000 amps minimum per mode.

I. The TVSS shall have a response time no greater than 5 nanoseconds, for any of the individual protection modes, under laboratory conditions with optimum lead lengths.

J. The TVSS UL 1449 surge suppression rating for any suppression mode shall not exceed:

Electrical System Voltage	Phases	UL 1449 Surge Suppression Ratings
120/240	1	330V
120/240	3	330V
120/208	3	330V
208	3	700V

277/480	3	700V
480	3	1500V

K. EMI/RFI filtering shall be provided for each mode with the capability to attenuate high frequency noise. Minimum attenuation shall be 20db.

L. The TVSS components shall have a SPDT alarm contact rated for 250 VAC, 1 amp (minimum) used for remote indication of circuit integrity.

M. TVSS shall be equipped with a non-resettable digital event counter readable on the face of the suppressor without opening any doors or covers.

2.04 CABINET/CONTROL PANEL SPD

A. The SPD shall be a Din-Rail-Mounted device and shall be installed to protect the equipment in the cabinet from harmful surges and voltage spikes. The SPD shall have a SPDT contact rated for 250 VAC, 1 amp used for remote indication/visual indicator of circuit integrity.

B. It shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 500V. The response time shall be less than or equal to 25 nanoseconds.

C. The device shall be a Phoenix Contact “Valvetrab” or equal.

2.05 PHONE BACKBOARD SPD

A. Telecommunications Copper Cabling Protector Modules - Provide in accordance with UL 497 solid state type 5 pin or screw type rated for the application. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

2.06 INSTRUMENTATION SPD

A. Local Surge Protection Device for Loop-powered 4-20mA instruments

1. The local surge protection device shall be installed at the location of the instrument it is protecting.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 10 ohms.

3. The device shall be Class 1, Div. 2 certified under UL1604 if it is located in a hazardous area as indicated on the Contract drawings.

4. The device shall be housed in a stainless steel pipe stub or similar for installation on a field-mounted conduit body. Temperature range shall be –40°C to 80°C.

5. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 270mA continuous current.

6. The device shall be a Phoenix Contact “Pipetrab” surge protection device, or equal.

B. Local Surge Protection Device for Line-Powered 4-20mA Instruments

1. Provide a surge protection device that protects both the 120VAC line supply and the 4-20mA loop output. Voltage clamp shall be no more than 325VAC on the line protection with 5 nanosecond response time. Surge current (8x20microsecond) shall be 39kA.

2. On the loop protection, voltage clamp shall be no more than 36V with 5 nanosecond response time and 10kA surge current rating.

3. Unit shall be NEMA 4X, highly corrosion resistant and suitable for direct sunlight exposure.

4. Unit shall be an Edco SLAC surge protector, or equal.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. The conductors shall be as short and straight as practically possible and shall not exceed 6 feet in length or the manufacturer's maximum recommended length (whichever is less). The input conductors are to be twisted together to reduce the TVSS system inductance. An appropriately sized manual safety/disconnect switch or thermal magnetic circuit breaker shall be installed on the line side of the TVSS. It shall be capable of electrically isolating the TVSS from the electrical service for repair without interrupting service to the building.

B. The TVSS shall be installed following the TVSS manufacturer's recommended practices and in compliance with all applicable codes.

3.02 DISTRIBUTION EQUIPMENT TVSS

A. TVSS shall be manufacturer-installed where indicated on the Drawing panelboard schedules and one-line/riser diagrams.

B. Provide a TVSS in all control panels with 3 phase power supply.

3.03 CABINET TVSS

A. Provide a Cabinet TVSS on all single phase control panels, SCADA and electronic cabinets, and all other equipment with solid-state circuitry.

3.04 INSTRUMENTATION SPD

A. Provide a local surge protection device at each instrument located outside of a building or in a vault.

END OF SECTION

SECTION 16440

MOTOR CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Contractor shall furnish and install motor control equipment as specified herein and as shown on the Drawings.

B. Provide manufacturer startup services for any motor control equipment that requires configuration or programming (soft starters, frequency drives, adjustable breakers, etc.)

1.02 RELATED WORK

A. Section 16010 – General Electrical Requirements

1.03 SUBMITTALS

A. Motor control equipment shall be new and the equipment of one manufacturer. Each component is specified by a particular trade name; however, this does not relieve the Contractor of the responsibility of submitting descriptive literature and Shop Drawings for review of all components. Motor control shall be the same brand as power distribution equipment on projects with both.

B. Shop drawings, including layout drawings, complete schematic and composite wiring diagrams, control circuit wiring diagrams and descriptive literature shall be submitted to the Engineer for review. Service manuals shall be submitted on all equipment and shall be bound in 3-ring looseleaf binders. The manuals shall also include information on accessories such as timers, etc., built in the control center.

C. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature. For example: Device boxes – Styles shall be listed as: For masonry walls, for electrical devices, for ceiling mounted light fixtures, etc

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Control Equipment

1. “Square D”, “Eaton”, “General Electric”. “Allen-Bradley” or equal.

2.02 MOTOR CONTROL CENTERS (MCC)

A. General

1. Quality of built-in transformers, starters, lighting panelboards, timers, etc. shall be as written elsewhere in this Division unless otherwise noted.

2. Motor Control Center(s) shall consist of one or more enclosed vertical sections joined together to form a rigid, free standing assembly. The construction of the Motor Control Center shall meet the requirements set forth by Underwriters’ Laboratories publication UL-845, NEMA publication number ICS-2-322, the National Electrical Code, and color coded.

3. The structure shall be UL listed and labeled as service equipment if applicable. All sections shall bear UL labels.

4. Enclosures shall be NEMA 1 unless otherwise indicated, and each control center suitable for connection to an available fault current of 65,000 RMS symmetrical amperes.

B. Construction

1. Vertical Sections

a. Vertical sections shall support the horizontal and vertical buses, combination starter units, covers and doors, and shall be designed to allow for easy rearrangement of units by the purchaser. Vertical sections shall have structural supporting members formed of a minimum of 13 gauge hot-rolled steel. All finished surfaces shall be blemish-free. Where needed, reinforcement structural parts shall be of 10-gauge steel to provide a strong rigid assembly. Each section shall be 90 inches high and shall have 7 gauge steel, 3 inch high removable lifting angle and two 1 ½ inch high base channels. Complete control center line-ups shall be divided into shipping splits no wider than approximately 60 inches. The lifting angle shall be provided on the top of each shipping split and shall extend the entire width of the shipping split. Lifting angles shall be designed to support the entire weight of the MCC section. Base channels shall be provided with holes to permit bolting the Motor Control Center(s) to the floor. The entire assembly shall be constructed and packaged to withstand all stresses induced in transit and during installation.

b. Motor Control Centers shall be designed so that matching vertical sections of the same current rating and manufacture can be added later at either end of the line-up without use of transition sections and

without difficulty or undue expense. Removable end closing plates shall be provided to close off openings on the end of the Motor Control Center line-up. A removable top plate shall be provided on each vertical section and shall be of one piece construction for added convenience in cutting conduit holes. The design shall allow use of the standard conduit entrance area without significant sag or deformation of the top plate.

c. Vertical sections shall be designed to accommodate plug-on units in front-of-board or back-to-back construction as shown on Contract Drawings. Vertical sections housing plug-on units shall be 20 inches wide and shall be 20 inches deep. Wider sections will be permitted only for bolted connection type units not fitting the 20 inch wide sections. Unit mounting area shall be divided into ½ space factor divisions, each approximately 6 inches. NEMA Size 1 and 2 combination starter units shall use only 1 space factor, or 12 inches, of unit mounting space. Vertical sections shall allow for 7 space factors of unit mounting space. Removable blank plates shall cover all unused unit mounting spaces. Blank plates shall be flanged on all 4 sides and shall be mounted with captive screws. Blank space shall be equipped for future use.

d. Vertical sections shall be provided with both horizontal and vertical wireways. Sufficient clearances shall be provided in the horizontal wireway so that no restriction is encountered in running wires from the vertical to horizontal wireway. Wireways shall be in accordance with the wireway sections contained in this document.

2. Horizontal Wireways

a. Horizontal wireways shall be provided in the top and bottom of each vertical section as indicated in the Contract Drawings and shall be arranged to provide full length continuity throughout the entire assembly. The top horizontal wireway shall have a cross sectional area of not less than 20 square inches with openings between sections of not less than 11 ½ square inches. The bottom horizontal wireway shall extend through the length and depth of the vertical sections and shall also be provided with openings of not less than 11 ½ square inches to allow for full length continuity throughout the entire assembly. The bottom horizontal wireway height shall be not less than 9 1/4 inches. Covers for all wireways shall be equipped with captive type screws to prevent loss of hardware during installation. All wireways shall be isolated from the bus bars.

3. Vertical Wireways

a. A vertical wire trough shall be located on the right -hand side of each vertical section and shall extend from the top horizontal wireway to

the bottom of the available unit mounting space. Each vertical wire trough shall have a cross sectional area of not less than 19 square inches and shall be isolated from the bus bars to guard against accidental contact. A separately hinged door having captive type screws shall cover the vertical wire trough to provide easy access to control wiring without disturbing control units.

b. Reusable wire ties shall be furnished in each vertical wire trough for the purpose of grouping and securely holding wires in place for a neat and orderly installation.

4. Busbars

a. A continuous main three-conductor horizontal bus shall be provided over the full length of the control center. A fully rated horizontal neutral bus (1200 ampere maximum) shall also be supplied over the full length of the Motor Control Center. When necessary, the bus shall be split to allow for ease in moving and handling. Splice bars will be supplied to join the bus wherever a split has been made. All splice connections shall be made with at least two bolts and shall employ the use of Belleville washers in the connection. Horizontal bus bars shall be mounted edgewise and supported by insulated bus supports.

b. For distribution of power from the main horizontal bus to each unit compartment, a three-phase vertical bus shall be provided. The vertical bus shall be firmly bolted to the horizontal bus for permanent contact.

c. The main horizontal and vertical buses shall be made of aluminum and the entire length shall be electrolytically tin plated to provide maximum protection to the bus bars from normal or adverse atmospheric conditions.

d. Bus supports shall be formed of high strength glass reinforced alkyd material. Bus supports shall have generous surface clearances in the vertical plane to shed dust and maintain dielectric integrity. Bus supports and insulators shall be red to indicate proximity of energized bus parts.

e. Horizontal and vertical buses shall have continuous current ratings adequate to handle all loads as shown on the one line diagram in the Contract Drawings. Continuous current ratings shall be in accordance with temperature rise specifications established by UL, ANSI, and NEMA standards.

f. A copper ground lug shall be provided in each incoming line vertical section capable of accepting a #8 to 250 MCM cable. A horizontal

copper grounding bus shall be provided in each section of the Motor Control Center. Horizontal grounding bus shall run continuously throughout the control center except where splits are necessary for ease of shipment and handling in which case splice bars shall be provided. Grounding bus shall be tin plated copper and have a cross sectional area equal to 28% of the main horizontal bus cross sectional area. Horizontal ground bus shall be located at the bottom of the Motor Control Center.

5. Bus Barriers

   a. Insulated horizontal and vertical bus barriers shall be furnished to reduce the hazard of accidental contact with the bus. Barriers shall have a red color to indicate proximity of energized buses. Vertical bus barriers shall have interlocking front and back pieces to give added protection on all sides and shall segregate the phases to reduce the possibility of accidental “flash over”. Small, separate openings in the vertical bus barriers shall permit unit plug-on contacts to pass through and engage the vertical bus bars. Bottom bus covers shall be provided below the vertical bus to protect the ends of the bus from accidental contact with fish tapes or other items entering from the bottom of the enclosure. Unused plug-on openings in the bus shall have plastic snap-in closing plates for added safety.

6. Main Incoming Lug Compartment

   a. A front accessible main lug compartment shall be provided with suitable main lugs to accommodate the number of cables per phase as indicated on the Contract Drawings. The compartment shall be located in the top most or bottom most unit space of the section to accommodate the user’s cables entering the Motor Control Center as indicated on the Contract Drawings. The main incoming lug compartment shall be covered by a hinged door for maintenance access. This door shall be held closed with captive type screws to discourage unauthorized access. (A unit door padlock attachment shall also be provided to lock the door in the closed position with one 5/16 inch diameter shackle padlock. This attachment shall also accept a meter type seal.)

7. Units

   a. Combination starter units shall consist of Size 1 minimum full voltage magnetic starters, autotransformer reduced voltage starters, molded case magnetic-only circuit breakers, and auxiliary control devices, as required and/or shown on the one-line and elementary diagrams. Pilot light assemblies (push-to-test) shall be transformer type. All auxiliary equipment, except that which is specified for mounting on the door, shall be mounted within the compartment. All units shall be

provided with unit doors, unit support pans, unit saddles and unit disconnect operators as outlined in this Specification. Each unit compartment shall be enclosed and isolated from adjacent units, buses and wireways except for openings for conductor entrance into units. Units shall be designed and constructed so that any fault will be localized within the compartment. All units shall be UL listed for minimum of 22,000 amperes RMS symmetrical fault withstand ability.

b. Plug-on combination starter units of the same NEMA size and branch feeder units of the same trip size shall be readily interchangeable with each other. It shall be possible to withdraw each plug-on unit to a de-energized position with the unit still being supported by the structure. It shall be possible to lock the unit in this position with one padlock.

c. Full voltage non-reversing combination starter units shall have the following minimum space factor requirements, shall be provided with plug-on connections and shall be provided with ample space for customer wiring room:

	Circuit Breaker Space Factor
Size 1	1
Size 2	1
Size 3	1 ½
Size 4	2

d. Provide anti-condensation heaters in each unit with a control transformer where the MCC is located outside or in a non-temperature or non-humidity controlled environment.

e. Provide ventilation equipment including fans and filtered louvers sufficiently sized to keep frequency drives cool for continuous operation. Ventilation should be sized for a maximum ambient temperature of 100°F in full sunlight.

8. Unit Plug-On

a. For convenient unit connection to bus bars, unit plug-on contacts shall be provided on the following units:

(1) For circuit breaker type units; full voltage starters, size 4 and smaller; auto-transformer reduced voltage starters, size 4 and smaller; part winding reduced voltage starters, size 4PW and smaller; branch circuit units, 225 ampere and smaller.

b. The plug-on connection for each phase shall be of a high quality two point connection and shall be designed to tighten around the vertical bus bar during a heavy current surge. For trouble-free connections, the plug-on fingers shall be silver plated and coated with a compound to assure a low resistance connection. Contact fingers shall be of a floating and self-aligning design to allow solid seating onto the vertical bus bars.

c. Starters NEMA size 4 and larger shall bolt directly to the vertical bus bars, circuit breakers rated higher than 225 amps shall also bolt directly to the bus bars.

9. Unit Doors

a. Each unit shall have a door securely mounted with rugged concealed-type hinges which allow the door to swing open a minimum of 112□ for unit maintenance and withdrawal. Doors shall be fastened to the structure so that they remain in place when a unit is withdrawn and may be closed to cover the unit space when the unit has been temporarily removed. Doors shall be held closed with captive type screws which engage self-aligning cage nuts. These screws shall provide at least two threads of engagement to hold doors closed under fault conditions. Each unit door shall be interlocked with its disconnect mechanism to prevent the door from opening when the unit is energized. A defeater mechanism shall be provided for defeating this interlock by authorized personnel. Removable door panels held with captive type screws shall be provided on starter unit doors for mounting push buttons, selector switches or pilot lights. Blank door panels capable of accepting future pilot devices shall be furnished when pilot devices are not originally specified for starter units. Each starter unit door shall house an external low-profile overload reset button for resetting the overload relay in the event of tripping.

10. Unit Support Pan

a. Each plug-on unit shall be supported and guided by a tilt and lift-out removable pan so that unit rearrangement can be easily accomplished. For easy unit installation and rearrangement, transfer of this unit support pan from one location to another shall be accomplished with ease after the control unit and door have been removed.

11. Unit Saddles

a. Each plug-on unit shall have a saddle of 14 gauge hot rolled steel designed and constructed to physically isolate the unit from the bus compartment and adjacent units. Saddlers shall be equipped with

captive, self-aligning mounting screws which shall hold the unit securely in place during shipment. Flanged edges shall be provided on each saddle to facilitate unit removal.

12. Disconnect Operators

    a. An external operator handle shall be supplied for each switch or breaker. This mechanism shall be engaged with the switch or breaker at all times regardless of unit door position to prevent false circuit indication. The operator handle shall be color coded to display red in the “ON” position and black in the “OFF” position. The operator handle shall have a conventional up-down motion and shall be designed so that the down position will indicate the unit is “OFF”. For added safety it shall be possible to lock this handle in the “OFF” position with up to three padlocks. The operator handle shall be interlocked with the unit door to prevent switching the unit to “ON” while the unit door is open. A defeater mechanism shall be provided for the purpose of defeating this interlock by a deliberate act of an electrician should he desire to observe the operation of the operator handle assembly or the unit components. Operators shall not be higher than 6'-6" above finished floor elevation, as installed.

13. Wiring

    a. The motor control center wiring shall be NEMA Class II, Type B.

    b. All wiring to the terminal strips from outside the MCC shall be made with spade type terminals of the proper size and rating for the wire used. Pull apart terminal blocks shall be provided in unit spaces of motor starters that contain field wiring energized from a remote source to comply with NEC Article 430-74.

    c. Each individual control conductor must be labeled and the labels must match the shop drawings and O&M manuals.

14. Finish

    a. The finish shall be manufacturer’s standard gray enamel applied over a rust inhibiting phosphate primer.

15. Optional Modifications and Accessories

    a. Additional modifications and accessories shall be as listed and specified on the Contract Drawings.

16. Identification

a. A control center identification nameplate describing section catalog numbers and characteristics shall be fastened on the vertical wire trough door of every section. Each control center unit shall have its own identification nameplate fastened to the unit saddle. These nameplates shall have suitable references to factory records for efficient communication with supplier. Each control center unit shall also have an engraved Bakelite nameplate fastened to the outside of each unit door inscribed as written on the Contract Drawings for ease in identification and for making changes when regrouping units. An overall structure nameplate is also required.

C. Starters and Overcurrent Protective Devices

1. Magnetic Starters

a. Magnetic starters shall be furnished in all combination starter units unless otherwise indicated on Contract Drawings. Starter Sizes 1 through 4 shall employ the use of a bell-crank lever design to transform vertical action of the armature into horizontal action of the contact carriers and thus minimize contact bounce and produce extra long contact life. Thermal overload relays on starters shall be ambient temperature compensated bimetallic type with selector for either auto or manual reset. Overload heater units shall be provided in each starter unit. Overload relay heater schedules shall be provided on each starter unit.

2. Circuit Breakers

a. All breakers sized 600A frame and larger shall have adjustable trip elements with the following adjustments: Long time pickup & delay, short time pickup & delay, Instantaneous, Ground fault pickup & delay.

b. Type FA, KA, LA, MA and PA molded case circuit breakers shall be furnished in all starter and branch feeder units using circuit breakers as a disconnect means. All circuit breakers will have a push-to-trip test feature for testing and exercising the circuit breaker trip mechanism.

3. Starters shall conform to requirements listed under individually mounted Motor Control Devices, hereinafter.

D. Lighting Panelboards

1. Lighting panelboards shall be as specified in other section of this Division. Lighting panelboard unit doors shall be held closed with captive latches that may easily be operated without the use of tools, i.e., wing nuts, handle, etc.

E. Transformers

1. 480 volt primary, 120/240 volt or 120/208 volt secondary transformers shall be as specified in other sections of this Division.

F. Electronic Circuit Monitors

1. Circuit Monitor Installation

a. Electronic circuit monitors shall be installed by the equipment manufacturer for all circuits as indicated on the Contract Drawings.

b. All control power, CT, PT, and communications wire shall be factory installed and harnessed within the lineup.

c. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's shop drawings must clearly identify the interconnection requirements, including wire type, to be used.

d. This equipment shall be Square D Power Logic, Eaton, General Electric, or equal.

2. Circuit Monitor Characteristics

a. The electronic circuit monitors shall accept inputs from industry standard instrument transformers (1 20 VAC secondary PTs and 5A secondary CTs). CTs are required on all three phases, and the neutral if there is a neutral present.

b. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate rms sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental of 60 Hz).

c. All setup parameters required by the circuit monitors shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.

d. The circuit monitor shall also maintain, in nonvolatile memory, a maximum and minimum value for each of the instantaneous values reported, as well as the time and date of the highest peak for all of the peak demand readings.

e. The circuit monitors shall be equipped with an integral LED display to provide local access to metered quantities.

f. The following instantaneous readings shall be reported by the circuit monitor:

(1) Frequency
(2) Temperature
(3) Current, per phase rms
(4) Current, 3-phase average rms
(5) Current, apparent rms
(6) Voltage, phase-to-phase & phase-to-neutral
(7) Power factor, per phase
(8) Power factor, 3-phase total
(9) Real power, 3-phase total
(10) Reactive power, 3-phase total
(11) Apparent power, 3-phase total
(12) Total Harmonic Distortion, voltage and current

g. The following demand readings shall be reported by the circuit monitor:

(1) Average demand current, per phase
(2) Peak demand current, per phase
(3) Average demand, real power
(4) Predicted demand, real power
(5) Peak demand, real power

h. The following energy readings shall be reported by the circuit monitor:

(1) Accumulated energy
(2) Accumulated reactive energy

3. Waveform Capture Capability

a. All electronic circuit monitors shall include waveform capture capability.

b. Upon a user-initiated command, the circuit monitor shall capture and store, in nonvolatile memory, 3-phase voltage and current samples consisting of 256 data points each.

c. These data points shall represent at least four cycles of each current or voltage waveform.

d. These samples shall be evenly gathered from three voltage and three current phases such that the original power signals with proper magnitude and phase relationships may be reconstructed.

e. It shall be possible to recreate the original power signal from the stored data with sufficient accuracy such that steady-state power harmonic analysis will provide valid information on harmonic content for up to the 30th harmonic of the fundamental power frequency.

4. Connecting and Networking Circuit Monitors

a. All data and calculated values stored in the circuit monitor shall be accessible to external devices by means of an Ethernet port with Modbus TCP or Ethernet/IP protocol.

5. System Display

a. The circuit monitor shall include an LED readout which will allow local display of the following electrical parameters:

(1) Current, per phase rms
(2) Voltage, phase-to-phase & phase-to-neutral
(3) Real power, 3-phase total
(4) Reactive power, 3-phase total
(5) Apparent power, 3-phase total
(6) Power factor, 3-phase total & per phase
(7) Frequency
(8) Peak demand current, per phase
(9) Peak demand, real power
(10) Accumulated Energy, (MWH and MVARH)
(11) Total Harmonic distortion, voltage and current

b. Reset of the following electrical parameters shall also be allowed from the front of the circuit monitor:

(1) Peak demand current
(2) Peak demand power
(3) Energy (MWH)
(4) Reactive energy (MVARH)

c. Circuit monitor setup for system requirements shall be allowed from the front of the circuit monitor. Setup provisions shall include:

(1) CT rating (xxxx:5)
(2) PT rating (xxxx:120)
(3) System type (3-wire and 4-wire)
(4) Demand interval (5-60 min.)

d. All reset and setup functions shall be keyswitch-protected to prevent unauthorized/accidental changes.

e. System display units shall be installed by the manufacturer in the equipment as indicated on the drawings.

f. The system display units shall be flush mounted on door panels.

g. The system display unit shall utilize a 4-line by 20-character, high contrast LCD technology display with backlighting to provide high reliability and superior readability in all light conditions.

2.03 INDIVIDUALLY MOUNTED MOTOR CONTROL DEVICES (480, 240, OR 120 VOLT)

A. General

1. All motor control equipment shall be new and the product of 1 manufacturer. All individually mounted disconnects, push-button stations, latchout stations, starters, etc., indoors shall be mounted on a 1 inch galvanized unistrut, 1 inch Kindorf channel, or equal to provide an air space at rear. Outside mounted equipment shall utilize 1 inch aluminum strut as required in 16070.

B. Starters

1. General

a. All starters shall be of the voltage rating, type, and sized for the motor size shown in these Specifications and/or on the Contract Drawings. For enclosure type see the system operation description and/or the Contract Drawings. All starters shall be of the magnetic type. Should a piece of electrically driven equipment be furnished with a larger motor than shown on the Contract Drawings, the proper size combination starter shall be provided for the equipment supplied, at no extra cost to the Owner.

b. See the Contract Drawings for the auxiliary equipment to be furnished and/or Section 16900 - Controls of this division. Maximum control voltage shall be 120 volts, a-c. Minimum starter size shall be NEMA Size 1.

2. Overloads

a. Each starter shall have a thermal overload device in each ungrounded leg. The overload shall be of the “Ambient compensated Bi-metallic”, thermal element type. All overloads shall be of the manual reset type and shall be reset without opening the starter enclosure. Heaters will be sized for the proper temperature rise of the motor that it is being used on. Heaters for general service shall be of the standard trip type. Adjustable Overload Relay Thermal Units are not allowed. All integral horsepower motors, 15

horsepower and over, require thermal elements embedded in the windings. See Motor Specifications, this division. Siemens-Allis overload relays shall be provided with a meter-sealed cover over relay adjustment controls.

3. Contactors

a. All contactors for motor starters shall be of the a-c magnetic type with “undervoltage” protection when used in conjunction with momentary contact push-button control and “undervoltage” release when used with maintained contact push-button control.

b. Contactor size shall be in accordance with NEMA Standards for the motor controlled and shall be horsepower rated.

c. Contacts shall be of the heavy duty silver-to-silver type and shall be totally enclosed in individual arc quenching chambers. Contacts shall be easily accessible for replacement.

d. The contactor coil shall be of the vacuum impregnated or epoxy resin type, moisture resistant and corrosion proof.

C. Control Stations

1. General

a. Control stations shall be heavy duty, maintained or momentary contact type, as noted on the Contract Drawings. Contacts shall be silver alloy, double break type. The number and marking of controls shall be as shown on the Contract Drawings. Enclosures shall be NEMA IV for indoor and outdoor mounting, unless otherwise noted on the Contract Drawings. All control stations shall operate on 120 volt, a-c maximum, unless otherwise designated on the Contract Drawings. “Latch-out” facilities shall be provided where called for in these Specifications and/or on the Contract Drawings.

2. Maintained Contact

a. Maintained contact control switches shall be marked “On” and “Off”. The button pushed shall remain in and push the other button out until the other button is pushed. In general, they are to be used for hand control of motors which have to operate continuously and restart whenever power is off then resumed, without any manual operator. This is needed for motors which have to operate continuously in the absence of an operator.

3. Momentary Contact

a. Momentary contact control push-button switches shall be marked “start” and “stop”. Pushbuttons shall spring out whenever pushed. If the circuit is dropped for any reason, operation cannot be resumed until a “start” push-button is pushed. In general, they are to be used for hand control of motors which are desired to operate intermittently in the presence of the operator and stop and start independently from more than one parallel control location.

D. Circuit Breakers

1. Circuit breakers shall be molded case type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any one pole shall open all poles simultaneously.

2. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

3. Breakers not used with motor starters shall be of the thermal magnetic type with a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

4. The breaker shall be trip indicating with the trip position midway between the “On” and “Off” positions.

5. Breakers for combination starters shall be 100 amp frame or larger. All breakers for combination starters shall be MAGNETIC (MAG-GUARD) TYPE and have an adjustable magnetic trip element of the motor circuit protector type.

6. Breakers for combination starters shall be F frame or larger. All breakers shall have adjustable magnetic trip elements. Circuit breakers K frame and larger shall have interchangeable thermal-magnetic trip elements.

E. Safety Switches

1. Safety switches shall be of the heavy-duty industrial, quick make, quick-break type. Ratings shall correspond to that of the equipment in which circuit it is used, fuses sized as shown on the Contract Drawings. All safety switches at motor locations are of the nonfused type unless otherwise noted.

2. Safety switches shall have a mechanical door interlock to prevent the door from being opened with the switch in the on position and facilities for locking it in the closed or open position.

3. Safety switches shall be UL98 listed and shall conform to the NEMA KS-1 standard, latest version. NEMA 4X enclosed safety switches where called for shall be stainless steel type 316 except in chemical areas where they shall be fiberglass. See the Drawings for NEMA rating requirements.

4. NEMA 1 enclosed switches shall be phosphate coated or equivalent, code gauge steel with baked enamel finish.

5. Double throw fused/nonfused safety switches, where required, shall be as specified on the Contract Drawings.

6. Safety switches shall be service-entrance rated where indicated and shall be lockable in both the “On” and “Off” positions.

7. Safety switches shall include auxiliary contacts to disconnect any motor control circuit power indicated on the Drawings as extending to the motor terminal box (for motor space heaters, embedded winding thermostats, etc.)

F. Selector Switches

1. Hand-off-automatic type selector switches shall be of oil-tight construction and shall have 3 positions. The switch must not have a spring loaded return. It shall be of the “quick-make”, “quick-break” type.
2. Selector switches for regular locations shall be 30mm, NEMA 4, Square D Class 9001 Type K or equal.
3. Selector switches for corrosive areas and water/wastewater plants shall be 30mm, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.

G. Pilot Lights and Pushbuttons

1. Pilot lights for corrosive areas and water/wastewater plants shall be 30mm, push-to-test, LED-style, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.
2. Pushbuttons for corrosive areas and water/wastewater plants shall be 30mm, NEMA 4X corrosion resistant, Square D Class 9001 Type SK or equal.

H. Manual Motor Starting Switches

Manual motor starting switches for the control of fractional horsepower motors shall be single pole, and shall be provided with a thermal heater of the correct size for the load controlled. Each starting switch shall be mounted where shown on the Contract Drawings. The motor starting switch shall be NEMA rated per the drawings. It shall be fiberglass in chemical or corrosive areas.

I. Control Relays

Control relays shall be magnetic, general purpose, "ice cube" type with 3-pole (minimum), double throw contacts rated at 5 amperes (minimum), 120 volts

(minimum). Coils shall be rated to operate at the indicated control voltage. Provide proper bases, mounting track, etc. for a complete installation. All relays shall be have a retainer clip, manual operator, and pilot light. Coils connected to solid-state digital outputs shall have transient surge protection.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Motor Control Centers

1. Ends of MCC(s) shall be closed with 1/4" mesh hardware cloth and galvanized or aluminized insect screen or sill covers to prevent the entrance of rodents and large insects into the MCC housing(s).

2. Each MCC shall be provided with a 4" high concrete pad.

3. One inch air space (min.) shall be allowed between back of MCC(s) and wall surface.

4. Lifting-eyes in tops of MCC(s) section shall be removed (and retained) and the threaded openings closed with stainless cap screws and plastic washers or plastic seals provided for that purpose by the MCC(s) manufacturer.

5. In installations where conduit runs to electrical equipment emanate from the top of MCC(s) there shall be provided additional wiring space in the form of metal trough(s) of the same metal housing(s) dimensions and details. Trough(s) shall be provided by the manufacturer of the MCC(s).

3.02 EXTRA STOCK/SPARE PARTS

A. Provide the following spare parts:

10 fuses of each type/amperage used

1 pilot light lamp for each pilot light socket assembly provided

1 control transformer for each size utilized

1 spare starter and overload unit for each size utilized

3.03 MANUFACTURER STARTUP SERVICES

A. Provide a manufacturer representative to commission and startup the equipment. This includes the configuration and programming of the equipment, and furnishing any

studies or engineering necessary to properly configure or program the equipment. Submit a field report and as-built documentation.

END OF SECTION

SECTION 16442

PANELBOARDS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide panelboards as indicated on the Drawings and as specified herein, including furnishing all labor, materials, equipment, and incidentals required for a complete installation.

B. Circuit breakers of size and type shown on Contract Drawings and described herein shall be provided with the panelboards.

1.02 SUBMITTALS

A. Shop Drawings, including Layout Drawings and complete over current protection devices descriptive literature shall be submitted to the Engineer for review.

B. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted.

C. Circuit assignments noted on the Drawings must match circuit assignments in all panelboards, and must be shown in shop drawings. Do not rearrange circuit numbering unless absolutely necessary due to inability to conform to the Drawings and then only rearrange the necessary breakers to match the Drawings as closely as possible.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. “Schneider/Square D”, “Siemens”, “General Electric,” “Eaton.” Substitution of alternate equipment shall be submitted for review to Engineer 10 days prior to bid.

2.02 EQUIPMENT

A. Rating

1. Panelboard ratings shall be as shown on the Contract Drawings. All panelboards shall be rated for the intended voltage.

B. Standards

1. Panelboards shall be in accordance with the Underwriter Laboratories, Inc. “Standard for Panelboards” and “Standard for Cabinets and Boxes” and

shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code.

C. Panelboard Construction

1. Interiors

a. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.

b. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

c. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

d. A nameplate shall be provided listing panel type, number of circuit-breakers and ratings.

2. Bussing

a. Bus-bars for the mains shall be of copper. Full size neutral bars shall be included. Bus-bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Bussing shall be braced throughout to conform to industry standard practice governing short circuit stresses in panelboards. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

b. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

c. Spaces for future circuit-breakers shall be bussed for the maximum device that can be fitted into them.

d. Separate neutral and ground bus shall be provided, insulated and isolated from each other.

3. Boxes

a. Recessed boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Surface mounted boxes shall be painted to match the trim. Boxes shall be of

sufficient size to provide a minimum gutter space of 4 inches on all sides.

b. Surface mounted boxes shall have an internal and external finish as hereinafter specified. NEMA 1 surface mounted boxes shall be field punched for conduit entrances.

c. At least 4 interior mounting studs shall be provided.

d. NEMA 4X boxes shall have a stainless type 316 enclosure. Quarter turn latches or 3-point latch is required. Screw clamps are not acceptable.

4. Trims

a. Hinged doors covering all circuit-breaker handles shall be included in all panel trims.

b. Doors shall have semi flush type cylinder lock and catch, except that doors over 43 inches in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Two keys shall be supplied for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

c. The trims shall be fabricated from code gauge sheet steel.

d. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with manufacturer's standard gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere without cracking or peeling.

D. Overcurrent Protective Devices (Circuit Breakers)

1. Panelboards shall be equipped with circuit-breakers with frame size and trip settings as shown on the Contract Drawings.

2. Circuit-breakers shall be molded case, bolt-in, thermal-magnetic trip.

3. Single Pole Circuit Breakers shall not be tied together to fabricate double or triple pole circuit breakers.

4. Circuit-breakers used in 120/208 volt panelboards shall have an interrupting capacity of not less than 10,000 amperes, RMS symmetrical.

5. Circuit-breakers used in 480 volt panelboards shall have an interrupting capacity of not less than 42,000 amperes, RMS symmetrical.

6. GFCI (ground fault circuit interrupter) shall be provided for circuits where indicated on the Contract Drawings. GFCI units shall be 1-pole, 120 volt, molded case, bolt-on circuit-breakers, incorporating a solid state ground fault interrupter circuit insulated and isolated from the circuit-breaker mechanism. The unit shall be UL listed Class A Group I device (5 milliamp sensitivity, 25 millisecond trip time), and an interrupting capacity of 10,000 amperes RMS.

7. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed so that an overload on any pole shall open all poles simultaneously.

8. The breaker operating mechanism shall be the quick-make, quick-break type and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit.

9. Breakers shall have a thermal bimetallic element for time delayed overload protection and a magnetic element for short circuit protection.

10. The breaker shall be trip indicating with the trip position midway between the “On” and “Off” positions.

11. Breakers for power distribution panels shall be F frame or larger. All breakers rated above 225 amps shall have interchangeable magnetic trip elements.

12. All breakers shall be UL listed, and conform to requirements of NEMA Standards.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Boxes for surface mounted panelboards shall be mounted so there is at least ½ inch air space between the box and the mounting surface.

B. Circuit directories shall be typed giving location and nature of load served.

C. Each panelboard shall be nameplated with plastic engraved nameplates stating the panel’s name, voltage, and the name of panel serving the panel. Nameplates shall be secured by use of stainless steel screws.

END OF SECTION

SECTION 16444

SOLID STATE REDUCED VOLTAGE MOTOR CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment, and services required to furnish and install solid state reduced voltage motor starters as shown on the Contract Drawings and as specified herein.

1.02 RELATED WORK

A. Special requirements for materials and equipment are given in Divisions 0 and 1.

B. Section 16440 – Motor Control

C. Section 16900 – Control Panels

1.03 SUBMITTALS

A. Submit shop drawings including descriptive literature, enclosure fabrication details, dimensions, weights, component layout drawings, front enclosure layout and nameplate engraving, enclosure paint systems and color, materials of construction, and wiring schematics, all tailored to this project.

B. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Wiring diagram must be specific to this project.

1.04 SYSTEMS DESCRIPTION

A. Motors as indicated in the Contract Drawings shall be provided with solid state starters as specified herein to limit power line disturbances and voltage drop on motor start-up.

B. The Contractor shall be responsible for coordinating the starter with driven equipment ratings and assuring compatibility.

1.05 QUALIFICATIONS

A. The equipment shall be manufactured by Allen Bradley, Eaton, Square D, or equal.

1.06 WARRANTY

A. This equipment shall have a warranty which shall be one (1) year, and shall run concurrently with the Contractor warranty on the entire project.

PART 2 - PRODUCTS

2.01 GENERAL DESCRIPTION

A. The soft start shall utilize a thyristor (SCR) bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors (NEMA Design B).

B. The soft start shall provide torque control for linear acceleration without external feedback independent of motor load or type of application. The gating of the thyristors shall be controlled in such a manner to ensure smooth and stable acceleration ramp.

C. The soft start shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms shall not be allowed.

D. All soft start power ratings will utilize the same control module.

E. A shorting contactor is required. For soft starter ratings up to and including 40A, the shorting contactor may be either integral to the soft-starter or external. For soft-starters rated above 40A, an external NEMA shorting contactor shall be supplied. Protective features and deceleration control options integral to the soft start shall be available even when the external shorting contactor is employed.

2.02 MOTOR DATA

A. Verify actual motor nameplate values prior to manufacturing of the soft starts.

2.03 RATINGS

A. The soft start shall be designed to operate in an ambient temperature 0□C to 50□C. Manufacturer literature shall indicate any temperature derating required, and Contractor shall conform to this requirement.

B. Storage temperature range shall be -25□C to 70□C.

C. Soft starter shall be able to withstand relative humidity up to 93% at 40□C, non-condensing.

D. The soft start shall be designed to operate in altitudes up to 3300ft. For higher altitudes, derate by 0.5% for each additional 330ft.

E. The soft start shall be capable of operation within +/-10% of nominal voltage rating.

F. The soft start shall automatically adapt for operation at 50 or 60 Hz. Frequency tolerance shall be +/- 5% when starting and +5% or -15% during steady state operation.

G. The soft start shall be capable of supplying 300% of rated full load current for 30 seconds at maximum ambient temperature.

H. The SCRs shall have a minimum P.I.V. rating of 1400 Vac. Lower rated SCRs with protection by MOVs are not acceptable.

2.04 ADJUSTMENTS AND CONFIGURATIONS

A. All dialogue functions, display units, remote functions, terminal blocks, configuration switches and adjustment potentiometers shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments shall be prohibited.

B. Digital indication shall provide, as a minimum, the following conditions:

1. Soft start status - ready, starting/stopping, run.

2. Motor status - current, torque, thermal state, power factor.

3. Fault status - Motor thermal overload, starter thermal fault, phase fault, frequency fault, supply fault, locked rotor fault, motor underload, max start time exceeded, external fault, serial link fault, phase inversion, internal failure, overcurrent.

C. The starter shall be preset to the following, however these settings shall be adjusted onsite by the Contractor for this specific project:

1. Torque acceleration ramp of 10 seconds.

2. Current limitation to 300% of the motor full load current rating.

3. Class 10 overload protection.

4. Motor current preset per NEC and UL tables for standard HP motors.

D. A digital keypad shall be utilized configure the following operating parameters as required:

1. Motor full load amps adjustable from 50 to 130% of the controller's rating.

2. Current limitation on starting adjustable from 1.5 to 7.0 times rated motor current, not to exceed 5.0 times the controller rating.

3. Torque ramp adjustable from 1 to 60 seconds.

4. Initial torque adjustable from 10 to 100% of nominal motor torque.

5. Torque limit adjustable from 10 to 200% of nominal motor torque.

6. Maximum start time adjustable from 10 to 999 seconds.

7. Voltage boost adjustable from 50 to 100% of the nominal supply voltage.

8. Selection of freewheel, soft stop or braking.

9. Adjustable soft stop torque ramp time from 1 to 60 seconds.

10. Threshold to change to freewheel following a soft stop from 0 to 100% of the nominal motor torque.

11. Braking torque level adjustable from 0 to 100% effectiveness.

12. Selection of Class 2, 10, 10A, 15, 20, 25 or 30 motor thermal overload protection.

E. A digital keypad shall be utilized configure the following controller parameters as required:

1. Selectable automatic reset operation.

2. Cancellation of the torque control loop for multi motor installations.

3. Adjustment of the stator loss estimation for specialty motors.

4. Assignment of controller inputs and outputs.

5. Activation of phase reversal protection.

6. Reset of motor thermal state.

7. Return to factory settings.

8. Activation of test mode for use with low power motors.

9. Indication of elapsed time in hours of starting, running and stopping.

F. Output relays shall provide the following status indications:

1. One form A (N.O.) and one form B (N.C.) minimum for indication of fault or control of an isolation contactor.

2. One form A (N.O.) for indication that torque ramp is complete and current is below 130% motor FLA (End of start).

G. Additional inputs and outputs shall be available to provide the following status indications:

1. One logic input for force to freewheel, indication of external fault, force to local control, control of cascading motors, or external motor overload reset.

2. One logic output for indication of motor thermal overload pre-alarm or presence of motor current and one logic output to indicate overcurrent alarm.

3. One analog output shall be available for 4 - 20 or 0 - 20 milliamp indication of motor current, torque, thermal state or power factor.

H. Relay and I/O functions listed above must be isolated with respect to common.

2.05 PROTECTION

A. A microprocessor controlled thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft start and provides:

1. An overload pre-alarm which indicates by relay contact that the motor has exceeded its rated temperature rise by 110%. This function shall be annunciation only.

2. A thermal fault condition which stops the motor if the temperature-rise exceeds 120% of the motor thermal capability.

3. An analog electronic circuit with a time constant adjustable to the motor's thermal cooling time constant ensuring the memorization of the thermal state even after power supply disconnection or shorting out of the power semiconductors.

B. The soft start shall provide phase loss, phase reversal, underload, stall, and jam protection.

C. The integral protective features shall be active even when the external shorting contactor is bypassing the SCRs.

2.06 CONTROLS

A. The soft start's control circuit shall be completely independent of the power circuit.

B. A special “pump control” algorithm shall be included, developed specifically to control starting/stopping of centrifugal pumps.

C. An Ethernet port shall be provided for soft starter communications and monitoring. Ethernet/IP or Modbus TCP protocol is acceptable.

2.07 MISCELLANEOUS

A. Additional devices to be furnished and installed with the solid state motor starter shall be as specified in Sections 16440 or 16900 and as shown on the control schematic provided in the Contract Drawings.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Solid state motor starters shall be treated as specified in General and Special Conditions.

3.02 INSTALLATION/APPLICATION/ERECTION

A. Installation shall comply with applicable codes and manufacturer's recommendations and instructions.

B. All free standing cabinets shall be anchored to their foundation.

3.03 FIELD PAINTING

A. Refer to Division 9 for enclosure paint requirements.

3.04 START-UP AND TRAINING

A. The manufacturer shall furnish the services of a factory technician to assist the Contractor in installation as required and the factory technician shall perform all adjustments and setup prior to operation. The settings shall be performed at the same time the driven equipment start-up personnel are on site to be sure all items operate well together. Furnish a written report to the Engineer on this start-up.

B. The start-up personnel from the factory shall provide Owner personnel with training as outlined in Section 16010.

3.05 TOOLS AND SPARE PARTS

A. Any special tools needed by the Owner for the future maintenance shall be provided as part of the lump sum bid.

B. Five (5) spare fuses shall be provided for each size/type used in this equipment.

C. One (1) spare pilot lamp/LED for each type used.

D. One (1) spare control circuit transformer of each type/size used shall be provided.

E. One (1) complete set of spare SCR assemblies (for all 3 phases) shall be provided for each size of starter.

END OF SECTION

SECTION 16460

TRANSFORMERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide transformers as indicated and as specified herein. Transformer locations and size shall be as shown on the Contract Drawings.

B. All transformers shall be non-PCB type.

1.02 SUBMITTALS

A. Submit product data on all equipment. Provide a schedule describing the application of each transformer including item served, size and voltage of transformer.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Schneider/Square D, General Electric, Siemens, Eaton, or equal.

2.02 FABRICATION

A. General Purpose Dry-Type Transformers

1. Single phase transformers shall be 480 or 600 volt primary and 120/240 volt secondary. Three phase transformers shall be 480 or 600 volts delta primary and 208 Y/120 or 240 volt delta secondary. Transformers 25 KVA and larger shall have a minimum of 4 (2 above, 2 below) 2 ½ percent full capacity primary taps.

2. Transformers shall be 150 degrees Celsius temperature rise above a 40 degrees Celsius ambient. All insulating materials are to be in accordance with the latest NEMA Standards for a 220 degrees Celsius UL recognized insulation system.

3. Transformer coils shall be of the continuous wire wound construction and shall be impregnated with non-hygroscopic, thermo-setting varnish. The coils shall also have a final wrap of electrical insulating material to prevent mechanical injury to the wire as well as increasing the electrical breakdown strength.

4. All cores shall be constructed of high grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point. The core laminations shall be clamped together with steel angles. The completed core and coil shall then be bolted to the base of the enclosure but isolated from the base by means of rubber, vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil to the enclosure. On transformers 500 KVA and smaller, the vibration isolation system shall be designed to provide a permanent fastening of the core and coil to the enclosure. To further facilitate vibration and noise isolation, the final section of conduit to the transformer shall be flexible.

5. Transformers 25 KVA and larger shall be in heavy gauge, sheet steel, ventilated enclosures. The ventilating openings shall be designed to prevent accidental access to live parts in accordance with UL, NEMA, and National Electrical Code Standards for ventilated enclosures. Transformers 25 KVA through 75 KVA shall be designed so they can either be floor or wall mounted. Above 75 KVA they shall be of the floor mounted design.

6. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed, and finished in the same color as the motor control equipment. For more details see Division 9 of these Specifications.

7. The maximum temperature of the top of the enclosure shall not exceed 50 degrees Celsius rise above a 40 degrees Celsius ambient.

8. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with NEMA and NEC Standards.

9. The transformer shall be marked “DANGER HIGH VOLTAGE” with labels specified in the section on marking, this Division.

10. The transformers shall be manufactured to requirements of applicable standards, especially as they apply to noise level and surface temperatures.

11. The transformers efficiency shall be DOE 2016 compliant.

PART 3 - EXECUTION

3.01 INSTALLATION / APPLICATION / ERECTION

A. Transformers shall be rigidly mounted to the structure or the foundation in the case of freestanding units.

B. Transformers shall be megger tested prior to energization.

C. Transformers with taps shall be adjusted to supply the nominal service voltage required on the secondary.

D. Transformers shall be installed in accordance with NEC requirements and manufacturer recommendations.

E. Ground secondary of transformer per NEC requirements.

END OF SECTION

SECTION 16483

ADJUSTABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SCOPE

A. Provide three-phase, Adjustable Frequency Drives (AFD) as specified herein and as shown on the Contract Drawings.

1.02 RELATED SECTIONS

A. Section 16010 General Electrical Requirements

B. Section 16440 Motor Control

1.03 REFERENCES

A. The adjustable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.
   1. Underwriters Laboratories (UL508C: Power Conversion Equipment)
   2. IEC 61800-3

1.04 SUBMITTALS

A. The following information shall be submitted to the Engineer for approval:
   1. Dimensioned outline drawing
   2. Schematic diagram
   3. Power and control connection diagram(s)
   4. Descriptive bulletins
   5. Product sheets

B. O&M manuals are required in accordance with Section 16010 requirements. As-built wiring diagrams and as-built parameter settings list are required.

1.05 QUALIFICATIONS

A. For the equipment specified herein, the manufacturer shall be ISO 9001 certified.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. A copy of these instructions shall be included with the equipment at time of shipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allen Bradley

B. Eaton

C. Square D

D. ABB

E. Or equal.

2.02 ADJUSTABLE FREQUENCY DRIVES – NEMA 4X FOR HVAC FANS ONLY

A. The AFD for the fans in the chemical areas shall be ABB ACS255 or equal, listed NEMA 4X with integral keypad and disconnect. It shall be rated for 50°C operation at continuous load without derating.

2.03 ADJUSTABLE FREQUENCY DRIVES FOR ALL OTHER APPLICATIONS

A. Adjustable frequency drives shall have the following features:

1. The AFD shall be rated for the voltage indicated on the Drawings. The AFD shall provide microprocessor-based control for three-phase induction motors. The AFD shall be constant torque rated for the horsepower indicated on the Drawings. It must be fully rated for continuous operation at 122°F (50°C).
2. The AFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source AFDs are not acceptable. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable.
3. The AFD shall have efficiency at full load and speed that exceeds 95% for AFD below 15-HP and 97% for drives 15-HP and above. The efficiency shall exceed 90% at 50% speed and load.
4. The AFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.
5. The AFD shall have a one (1) minute overload current rating of 150% and a three (3) second overload current rating of 180% for constant torque drives. The AFD shall have a one (1) minute overload current rating of 110% for variable torque drives.
6. The AFD shall be capable of operating of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
7. The AFD shall have an integral EMI/RFI filter as standard.
8. AFDs rated 5HP and below are not required to have line reactors. AFDs rated 6HP to 20HP shall have a standard 3% nominal impedance AC three-phase line reactor. AFDs above 20HP shall have a standard 5%

nominal impedance AC three-phase line reactor. The line reactors may be integral to or separate from the drive.

9. The AFD shall be able to start into a spinning motor. The AFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
10. Standard operating conditions shall be:
    a. Incoming Power: As indicated voltage (+10% to -15%) and 50/60 Hz (+/-5 Hz)
    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
    c. Speed regulation of +/- 0.5% of base speed.
    d. Load inertia dependant carryover (ride-through) during utility loss.
    e. Insensitive to input line rotation.
    f. Humidity: 0 to 95% (non-condensing and non-corrosive).
    g. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
    h. Ambient Temperature: -10 to 50 °C (CT),
    i. Storage Temperature: -40 to 60 °C.
11. Control Functions
    a. AFD programmable parameters shall be adjustable from a digital operator keypad. The AFD shall have a alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall have backlighting.
    b. The keypad shall include a Local/Remote pushbutton selection. Both start/ stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
    c. The frequency drive shall include an Ethernet port for programming, monitoring, and control. Ethernet/IP is the required protocol.
    d. The operator shall be able to scroll through the keypad menu to choose between the following:
        1. Monitor
        2. Operate
        3. Parameter setup
        4. Actual parameter values
        5. Active faults
        6. Fault history
        7. Information to indicate the standard software and optional features software loaded.
    e. The following setups and adjustments, at a minimum, are to be available:
        1. Start command from keypad, remote or communications port

2. Speed command from keypad, remote or communications port
3. Motor direction selection
4. Maximum and minimum speed limits
5. Acceleration and deceleration times, two settable ranges
6. Critical (skip) frequency avoidance
7. Torque limit
8. Multiple attempt restart function
9. Multiple preset speeds adjustment
10. Catch a spinning motor start or normal start selection
11. Programmable analog output
12. DC brake current magnitude and time
13. PID process controller

12. The AFD shall have the following system interfaces:
    a. Inputs – A minimum of four (4) programmable digital inputs, two (2) analog inputs and Ethernet communications interface shall be provided with the following available as a minimum:
        1. Remote manual/auto
        2. Remote start/stop
        3. Remote forward/reverse
        4. Remote preset speeds
        5. Remote external trip
        6. Remote fault reset
        7. Process control speed reference interface, 4-20mA DC
        8. Potentiometer and 1-10VDC speed reference interface
        9. Ethernet programming and operation interface port

B. Outputs – A minimum of two (3) discrete programmable digital outputs and two (2) programmable analog outputs shall be provided, with the following available at minimum.
    1. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available at minimum:
        a. Fault
        b. Run
        c. Ready
        d. Reversed
        e. Jogging
        f. At speed
        g. Torque Limit Supervision
        h. Motor rotation direction opposite of commanded
        i. Over-temperature
    2. Programmable analog output signal, selectable with the following available at minimum:
        a. Motor current
        b. Output frequency

c. Frequency reference
d. Motor speed
e. Motor torque
f. Motor power
g. Motor voltage
h. DC-bus voltage
i. AI1 (Analog Input 1)
j. AI2 (Analog Input 2)
k. PT100 temperature

3. Monitoring and Displays
   a. The AFD display shall be a LCD type capable of displaying the following thirteen (13) status indicators:
      1. Run
      2. Forward
      3. Reverse
      4. Stop
      5. Ready
      6. Alarm
      7. Fault
      8. Input/Output (I/O) terminal
      9. Keypad
      10. Bus/Communication
      11. Local (LED)
      12. Remote (LED)
      13. Fault (LED)
4. The AFD keypad shall be capable of displaying the following monitoring functions at a minimum:
   a. Output frequency
   b. Frequency reference
   c. Motor speed
   d. Motor current
   e. Motor torque
   f. Motor power
   g. Motor voltage
   h. DC-bus voltage
   i. Unit temperature
   j. Calculated motor temperature
   k. Voltage level of analog input
   l. Current level of analog input
   m. Digital inputs status
   n. Digital and relay outputs status
   o. Analog Input
5. Protective Functions

a. The AFD shall include the following protective features at minimum:
    1. Over-current
    2. Over-voltage
    3. Inverter fault
    4. Under-voltage
    5. Input phase loss
    6. Output phase loss
    7. Under-temperature
    8. Over-temperature
    9. Motor stalled
    10. Motor over-temperature
    11. Motor under-load
    12. Logic voltage failure
    13. Microprocessor failure
  b. The AFD shall provide ground fault protection during power-up, starting, and running. AFD with no ground fault protection during running are not acceptable.
6. Diagnostic Features
  a. Fault History
    1. Record and log faults
    2. Indicate the most recent first, and store up to 30 faults
7. Spare Parts
  a. The main logic board, keypad and power supply board shall be supplied as spares, one for each different part number supplied.
8. The AFD manufacturer shall maintain, as part of a national network, engineering service facilities within 200 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.

PART 3 EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
  1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
  2. After all tests have been performed, each AFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
  3. After the burn-in cycle is complete, each AFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 INSTALLATION

A. Install per manufacturer’s instructions.

B. Configure parameters according to actual driven motor nameplate data.

C. Set the minimum and maximum speeds as directed by the motor manufacturer.

3.03 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of AFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer’s installation instructions, wiring, application dependant adjustments, and verification of proper AFD operation.

B. The Contractor under the technical direction of the manufacturer’s service representative shall perform the following minimum work.

1. Inspection and final adjustments.
2. Operational and functional checks of AFD and spare parts.
3. The Contractor shall certify that he has read the drive manufacturer’s installation instructions and has installed the AFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

3.04 MAINTENANCE / WARRANTY SERVICE

A. Warranty shall be a minimum of two years from the date of start-up and include all parts, labor, and travel time.

3.05 TRAINING

A. The Contractor shall provide a training session for up to 5 owner's representatives for ·one normal workday. Training and instruction time shall be in addition to that required for start-up service.

B. The manufacturer’s qualified representative shall conduct the training.

C. The training program shall consist of the following:

1. Instructions on the proper operation of the equipment.
2. Instructions on the proper maintenance of the equipment.

END OF SECTION

SECTION 16495

SWITCHBOARD MATTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Switchboard matting shall be furnished by the Contractor and placed in front of all power distribution and control equipment as indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Switchboard matting shall be W.H. Salisbury & Company, Safety Line, Inc., Tepromark, Wearwell, Erico, or equal.

2.02 MATERIALS

A. Switchboard matting shall be nonconductive with a minimum of 40,000 volts dielectric strength. The mat shall have a corrugated, non-slip surface and shall be a minimum of 1/4 inch thick. Width shall be 36 inches and length shall be as required at each location. The mat shall be black in color, ozone and oil resistant, and manufactured to meet all applicable ANSI/ASTM standards.

PART 3 - EXECUTION

A. Install per manufacturer instructions.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide light fixtures as indicated on the Drawings and as specified herein. The specific characteristics of the light fixtures to be furnished and installed shall be as detailed in the light fixture schedule on the Contract Drawings.

1.02 RELATED WORK

A. Related Sections: The following sections contain requirements that related to this section.

1. Division 1 – General Requirements

2. Section16010 – General Electrical Requirements

1.03 SUBMITTALS

A. General: Submit shop drawings in accordance with Section 16010 General Electrical Requirements and the General and Special Conditions. The lighting submittal shall be complete with all fixtures listed utilizing the same tagging convention as listed in the Light Fixture Schedule on the Drawings. The minimum data for each light fixture shall include complete photometrics, electrical characteristics, construction characteristics, and options clearly highlighted or circled.

B. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers are Holophane, Lithonia, Cooper, Hubbell, or equal.

2.02 BALLASTS

A. Electronic ballasts with less than 10% THD (Total Harmonic Distortion) shall be

provided with luminaires.

B. All Luminaires shall be quiet. If a Luminaire develops a noticeable hum within the warranty period, the Luminaire shall be replaced without cost to the Owner.

2.03 LUMINAIRES

A. All fixtures shall be delivered complete with suspension and mounting accessories, ballasts, diffusers, reflectors, etc., all wired and assembled. All accessory wiring shall be furnished and installed as shown on the Contract Drawings.

B. All supports required for luminaires in addition to that furnished under the general building construction shall be furnished and installed by the Contractor.

C. When fixtures are noted to be installed flush, they shall be complete with the proper accessories for installing in the particular ceiling involved. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

2.04 LAMPS

A. Color temperature shall be 4000k unless indicated otherwise on the Contract Drawings.

B. Minimum Color Rendering Index (CRI) shall be 80 unless otherwise indicated.

2.05 LIGHTING CONTACTORS

A. Contactor shall be NEMA ICS 2, electrically held contactor. Contacts shall be rated 600 volts, 30 amperes, and shall include the number of poles indicated on the Drawings. Coils shall be rated for the voltage indicated on the Drawings. Provide in NEMA 1 enclosure conforming to NEMA ICS 6 unless otherwise indicated. Contactor shall have silver alloy double-break contacts. Provide contactor with hand-off-automatic selector switch. Contactor shall be Square D, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General:

1. The Contractor shall furnish all light fixtures, lighting equipment, components, hangers, etc., as shown on the Contract Drawings and shall install them at the locations shown on the Contract Drawings.

2. Deliver lighting fixture in individually wrapped in factory containers. Stack and store in accordance with manufacturer's instructions.

3. All fixtures must be UL labeled and listed.

4. Lamps are required in all fixtures, whether indicated in the Schedule or not.

5. Locations of fixtures shall be coordinated with reflected ceiling plans where they exist. Any conflicts between electrical plans and Engineer's reflected ceiling plans, the reflected plans shall override.

B. Luminaires:

1. All recessed fixtures shall be securely fastened per detail on the drawings.

2. Mounting heights specified as indicated shall be to bottom of fixture. Coordinate exact mounting of lighting fixture with type, style and pattern of ceiling being installed.

3. Any fixtures damaged prior to final completion shall be replaced by Contractor.

4. Replace lamps in lighting fixture which are observed to be inoperable or noticeably dimmed prior to final completion or within the warranty period.

5. Flexible fixture hangers shall be used for all pendant-mounted fixtures.

6. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Junction boxes shall be supported from the structure. No conduit shall be lying on ceiling tile.

7. No light fixtures shall be hung or installed until after painting is completed, however, the Contractor shall provide temporary lighting. Fixtures in suspended ceilings shall be fastened to the main tees of the ceiling grid.

8. All fixtures shall be left in a clean condition, free of dirt and defects, and shall be cleaned prior to final completion.

END OF SECTION

SECTION 16580

OCCUPANCY SENSORS

PART 1 – GENERAL

1.01 SUMMARY

A. The Occupancy Sensor system shall sense the presence of human activity within the desired space and fully control the “On” / “Off” function of the loads automatically. Sensors shall turn “On” the load within 2 feet of entrance and shall not initiate “On” outside of entrance.
B. The Contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.
C. Product shall be warranted for 5 years.
D. The Occupancy Sensor shall be designed to override to the “Off” position when wired in conjunction with a standard wall type light switch.

PART 2 – PRODUCTS

2.01 MANUFACTURERS AND SUBSTITUTIONS

A. Manufacturers shall be Sensor Switch, GE, Leviton, Novitas, or equal.
B. Alternate Manufacturers shall be submitted no less than 5 days prior to bid date. All substitutions must provide technical literature. All substitutions must clearly identify any and all exceptions to the specifications with a detailed explanation as to the exception.
C. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature. For example: Device boxes – Styles shall be listed as: For masonry walls, for electrical devices, for ceiling mounted light fixtures, etc.
D. Active Ultrasonic sensing technology shall not be accepted.
E. Sensing technologies shall be completely passive in nature. The occupancy sensor system shall not emit or interfere with any electronic device, or human characteristic. Acceptable technology is PIR/Microphonic Passive Dual Technology.
F. Time Delay settings shall be factory set at 10 minutes, and shall not be adjusted unless specifically instructed. Maximum adjustment shall be 20 minutes. Automatic adjustments to this delay period by the sensor shall not be permitted.
G. All line voltage devices shall be UL Listed under Energy Management Equipment, or Industrial Control Equipment. UL Listing under Appliance Control shall not be accepted.

2.02 WALL SWITCH SENSORS – SMALL AREAS

A. Sensor shall recess into single gang switch box and fit a standard GFI opening.
B. Sensor must meet NEC grounding requirements by providing a dedicated ground connection and grounding to mounting strap. Line and load wire connections shall be interchangeable.
C. Sensor shall use PIR sensing incorporating a nominal one half inch focal length lens viewing 9 inches above and below horizontal view pattern measured at 10 feet.
D. Sensor shall have optional features for photocell/daylight override, vandal resistant lens, and no switch as specified.
E. In areas with inboard/outboard switching, sensor shall provide two dedicated relays and override switches.
F. In areas with obstructions to the occupant's workspace, sensor shall utilize dual technology PIR/Microphonic sensing.
G. Sensor shall be the following Sensor Switch model numbers. Device color and optional features as specified.
    1. WSD-PDT (PIR/Microphonic), or equal.

2.03 WALL SWITCH SENSORS – LARGE AREAS

A. Sensor shall surface mount to single gang switch box.
B. Sensor shall use PIR sensing incorporating a nominal one-inch focal length lens viewing 9 inches above and below horizontal view pattern measured at 20 feet.
C. Sensor shall have optional feature for photocell/daylight override.
D. In areas with inboard/outboard switching or two circuits, sensor shall provide two dedicated relays and override switches.
E. In areas with obstructions to the occupant's workspace, sensor shall utilize dual technology PIR/Microphonic sensing.
F. Sensor shall be the following Sensor Switch model numbers. Device color and optional features as specified.
    1. LWS-PDT (PIR/Microphonic) , or equal.
    2. LWS-PDT-2P (PIR/Microphonic inboard/outboard or two circuits), or equal.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. General:
    1. The Contractor shall furnish all equipment, components, interconnecting wiring, hangers, etc., as shown on the Contract Drawings and shall install sensors at the locations shown on the Contract Drawings.

2. All occupancy sensor wiring shall be in conformance with the latest revision of the NEC and UL standards. All units shall be UL labeled and listed.
3. All conductors and wiring shall be provided per Manufacturer's recommendations in ¾" conduit.
4. Contractor, in accordance with manufacturer's recommendation, shall determine final sensor location. All sensors shall have non-adjustable factory calibrated sensitivity for maximum performance. Time Delay and Photocell field adjustments shall be provided as needed.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide lightning protection systems for the Spring Water Pump station building, the Chlorine/Fluoride building, and the Filter Addition building.

B. The lightning protection systems shall be furnished, installed, and connected to provide a complete and functional system. Installation and equipment construction shall comply with Lightning Protection Institute Installation Code LPI-175, UL Master Label Code 96A, and NFPA 780.

C. The Contractor shall provide shop drawings indicating location and installation of equipment for review of the Engineer before beginning installation.

D. All equipment shall be of the same manufacturer, insofar as possible.

E. Equipment specified herein supplements actual suppression devices specified in Section 16280.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. “Thompson Lightning Protection, Inc.,” “Independent Protection Co., Inc.,” “National Lightning Protection, Inc.” or equal.

2.02 EQUIPMENT

A. All equipment used in this installation shall be UL approved and labeled in accordance with UL procedures, with each air terminal bearing an “A” label and all main conductors bearing a “B” label at 10'-0" intervals.

B. All equipment shall be new, and of design and construction to suit the application where it is used in accordance with accepted industry standards and LPI and UL code requirements and as per manufacturers recommendations.

C. Downlead conductors from roof to ground shall be copper, of 28 strands, 17 gauge minimum. All main roof conductors shall be aluminum, of 24 strands, 14 gauge minimum.

D. Air terminals shall be solid, round aluminum bar of ½" minimum diameter, and shall project 10" minimum above the object to be protected.

E. Air terminal bases shall be of cast aluminum with bolted pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Bases on built-up tar and gravel roofs shall be secured with a proper adhesive and shall have a minimum surface contact area of 18.5 square inches.

F. Ground rods shall be a minimum of 3/4" in diameter and 10'-0" long. They shall be connected to the system using exothermic welds, Cadweld, or equal.

G. Cable fasteners shall be substantial in construction, electrolytically compatible with the conductor and mounting surface and shall be spaced according to LPI and UL code requirements.

H. Bonding devices, cable splicers and miscellaneous connectors shall be of cast aluminum with bolted pressure connections to cable. Cast or stamped crip fittings are not acceptable.

I. Equipment on stacks and chimneys shall be protected from corrosion and sized in accordance with LPI and UL requirements.

J. All miscellaneous bolts, nuts, and screws shall be stainless steel.

K. An approved bimetal transition fitting shall be used at the roof level to change from aluminum roof conductor to copper downlead cable.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. The installation shall be accomplished by an experienced installer listed with Underwriters' Laboratories as qualified and who is also a Certified Master Installer of the LPI or working under the direct supervision of an LPI manufacturer as listed above or his authorized LPI Certified Master Installer representative.

B. All equipment shall be installed in a neat workmanlike manner in the most inconspicuous manner possible. The system shall consist of a complete cable network on the roof including all air terminals, splices, and bonds with cable downleads routed concealed either directly in the building construction for a new structure or in conduit to ground for an existing structure.

C. The copper downlead cables shall not be brought directly through the roof. Through roof connectors with solid rods or conduits though pitch pockets shall be utilized for this purpose.

D. The limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in UL 96A and LPI 175 shall be observed. The lightning protection installer will work with other trades to ensure a correct, neat, and unobtrusive installation.

E. It shall be the responsibility of the lightning protection installer to assure a sound bond to the metallic main water service and to assure interconnection with other building ground systems, including both telephone and electrical and also to ensure that proper arresters have been installed on the power service.

F. Downlead conductors from roof to ground shall be protected from mechanical damage from a point 8 feet above to 1 foot below grade by conduit or other means. Downlead conductors must be installed CONCEALED on all new construction. Surface-mounted conduits/raceways will only be allowed on existing facilities that are being upgraded with lightning protection systems.

G. The lightning protection installer shall secure and deliver a UL Master Label and LPI System Certification to the Engineer for the Owner upon completion of the installation.

H. The Contractor shall also submit 2 copies of as built shop drawings, 1 with the UL Master Label Application Form and another with LPI forms 175A and B.

I. A permanent plate shall be affixed to the protected structure in a prominent location, indicating its UL approval.

END OF SECTION

SECTION 16710

BUILDING TELECOMMUNICATIONS CABLING SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide a building telecommunications cabling and pathway system which shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware.

B. Provide telecommunications outlet assemblies where indicated on the Contract Drawings.

C. Relocate Owner's existing phone equipment to new phone backboard and make existing phone handsets and internet service operational. Provide a new amplified P.A. speaker along with circuitry to annunciate a phone call condition. Coordinate to minimize downtime of existing systems.

D. The Contractor shall contact the Telephone Company, the Internet Service Provider, and the Cable Company, with regard to any special requirements for the telecommunications system and shall meet those requirements at no extra cost to the Owner.

E. Provide grounding as specified herein and as indicated.

F. Relocate and secure existing cabling and appurtenances in areas of demolition and in any areas where required for installation of equipment required under this Contract regardless of whether or not the relocation is indicated on the Drawings.

1.02 RELATED WORK

A. Drawings and General Provisions of this Contract including General and Supplementary Conditions and Division 1 Specifications Sections, apply to work of this Section.

B. Section 16010 – General Electrical Requirements

C. Section 16130 - Raceways

D. Section 16131 – Boxes

E. Section 17200 – SCADA Hardware

1.03 REFERENCES

A. The publications of the standards organizations listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the organization abbreviation with applicable publication number.

1. ASTM INTERNATIONAL (ASTM)

2. ELECTRONIC INDUSTRIES ALLIANCE (EIA)

3. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

4. INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

5. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

6. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

7. U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

8. UNDERWRITERS LABORATORIES (UL)

9. U.S. Dept. of Agriculture (USDA) – (RUS)

1.04 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, EIA TIA/EIA-568-C.3, EIA TIA/EIA-569-A, EIA TIA/EIA-606-A and IEEE Std 100 and herein.

B. Telecommunications Room (TR) - An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

C. Entrance Facility (EF) (Telecommunications) - An entrance to the building for both private and public network service cables including the entrance point at the building wall and continuing to the entrance room or space.

D. Entrance Room (ER) (Telecommunications) - A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

E. Open Cable - Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

F. Open Office - A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

G. Pathway - A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.05 SUBMITTALS

A. The submittals listed below are required and shall be submitted in accordance with Section 16010. Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical society publication references.

B. Shop Drawings/Product Data (submit prior to procurement/installation)

1. Telecommunications block (one-line) diagram - Shall show all equipment, cabling, and outlets with unique identifiers (tags) for all equipment and cables.

2. Telecommunications plans – Provide drawings in accordance with EIA TIA/EIA-606-A. The identifier for each termination and cable shall appear on the drawings. The plans shall include a layout of complete building per floor, including Building Area Boundaries, Backbone Systems, Horizontal Pathways, Drop Locations and Cable Identification (ID’S). The plans shall include details that identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Include typical details for terminations. Floor plans in

AutoCAD™ format are available from the Architect/Engineer for a fee of $100 per sheet.

3. Product data – Shall include telecommunications cabling, patch panels, telecommunications outlet/connector assemblies, connector blocks, equipment support frames, and all other equipment to be installed.

4. Manufacturer Test Reports – Shall include manufacturer's factory reel test.

5. Certificates – Shall include Telecommunications Contractor qualifications, Key Personnel qualifications, and Manufacturer qualifications

6. Test plan - Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the UTP and optical fiber components and accessories. Include procedures for certification, validation, and testing.

7. Network Architecture & Security Submittal – Provide a submittal including key networking components, proposed IP addressing of each component, Layer 3 switch config, VLAN config, remote access/VPN config, and security protocols.

C. Operation and Maintenance Manuals (submit when installation is substantially complete)

1. Include operation and maintenance information, including user manuals for all equipment.

2. Include all information in the shop drawing/product data submittal with updated as-built information and drawings.

3. Submit any required telecommunications management software on Compact Disk, along with a backup copy of any electronic databases or files developed during the course of the project.

D. Test Reports – Submit a binder with report of all testing required by Part 3 of this Section. Each cable shall have an individual test report signed and certified by the tester.

1.06 QUALITY ASSURANCE

A. Work under this section shall be performed by and the equipment shall be

provided by an approved telecommunications contractor and key personnel. Qualifications shall be provided for the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

B. Telecommunications Contractor - The Contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The Contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the Contractor.

C. Key Personnel:

1. Installers: The supervisor assigned to the installation of this system or any of its components shall be a Building Industry Consulting Services International (BICSI) Registered Cabling Installer, Level 2 (minimum). Submit documentation of current BICSI certification. They shall also have factory or factory-approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel.

2. The Network professional shall be a Cisco Certified Network Professional or Microsoft Certified Network Engineer. Submit documentation of current certification for key person. Netcomm, Inc. of Lexington, KY, DDAF of Lexington, KY, or Box Lake of Winchester, KY (or equal) are acceptable Network professional services firms.

D. Minimum Manufacturer Qualifications - Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2 and EIA TIA/EIA-568-C.3.

E. Regulatory Requirements - Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

F. Standard Products - Provide materials and equipment that are products of

manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer. Products manufactured more than 3 years prior to date of delivery to site shall not be used.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Connecting hardware shall be rated for operation under ambient conditions of 0 to 60 degrees C (32 to 140 degrees F) and in the range of 0 to 95 percent relative humidity, noncondensing.

1.08 WARRANTY

A. The warranty shall comply with the General Conditions of this Contract.

1.09 SPARE PARTS

A. Furnish one spare switch for each unique switch installed.

B. Furnish one spare power supply for each unique power supply installed.

1.10 NETWORK ARCHITECTURE AND SECURITY REQUIREMENTS

A. The network & security architecture shall be designed by a certified network professional as specified above. System shall be designed to prevent unauthorized intrusion or attack.
B. The network shall be segmented into VLANs – one for control/SCADA system and one for general data. A third VLAN should be configured for the existing video surveillance system.
C. The security appliance shall be configured for secure VPN access to the network by authorized personnel (no more than 3 simultaneous connections). For bidding purposes, approximately ten (10) separate VPN user accounts will need to be configured.
D. The approved network professional will be responsible for IP addressing, managed switch/router configuration, and security appliance configuration. Coordination with SCADA contractor and Filter Control system supplier is required.

E. A submittal must be prepared and submitted to Engineer for approval, and O&M manuals must be submitted documenting equipment installed, configuration settings, IP addressing, procedures for VPN connection, etc.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cabling and Accessories

1. Copper – “Belden,” “Alpha Wire,” “General Cable,” or equal.

2. Fiber – “Corning,” “Belden,” “Alpha Wire,” “General Cable,” or equal.

B. Cable Runway and Accessories

1. “B-Line,” “Homaco,” “Chalfant,” or equal.

2.02 COMPONENTS

A. All components shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.03 TELECOMMUNICATIONS PATHWAY

A. Provide telecommunications pathways in accordance with EIA TIA/EIA-569-A and as specified herein.

B. Conduit and Surface Metal Raceways – See Section 16130 for requirements.

C. Open Telecommunications Cable Support – Above tile ceilings only

1. Open Top Cable Supports - Provide open top cable supports in accordance with UL 2043. Open top cable supports shall be galvanized steel.

2. Closed Ring Cable Supports - Provide closed ring cable supports in accordance with UL 2043. Closed ring cable supports shall be galvanized steel.

2.04 TELECOMMUNICATIONS CABLING

A. Cabling shall be UL listed for the application and shall comply with EIA TIA/EIA-568 and NFPA 70. Provide a labeling system for cabling as required by EIA TIA/EIA-606-A and UL 969. Cabling manufactured more than 12 months prior to date of installation shall not be used.

B. Exterior Cabling

1. Phone Cable (Outside Plant) – Shall be RDUP/RUS PE-89 filled foam insulated telephone cable, 22 AWG, water blocked and designed for installation in underground ducts with 0.006” steel tape armor. General Cable Type 2007 or equal.

2. Optical Fiber

a. Provide in accordance with ICEA S-83-596, EIA TIA/EIA-568-C.3, UL 1666 and NFPA 70. Cable shall be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 40 inches.

b. Backbone fiber shall be EIA TIA/EIA-492CAAA, single-mode, 8/125-um diameter, 0.10 numerical aperture, tight buffered fiber optic cable. Cable shall have six (6) single-mode fiber optic units. Provide nonconductive optical fiber general purpose cable (OFN or OFNG), nonconductive optical fiber plenum cable (OFNP), and nonconductive optical fiber riser cable (OFNR) rated cable in accordance with NFPA 70 and UL 910. Type OFNP or OFNR may be substituted for type OFN or OFNG and type OFNP may be substituted for type OFNR in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color shall be in accordance with EIA TIA/EIA-598-B.

C. Horizontal Cabling - Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with EIA TIA/EIA-568-C.1.

1. Horizontal Copper - Provide horizontal copper cable in accordance with EIA TIA/EIA-568-C.2, UL 444, ICEA S-90-661 UTP (unshielded twisted pair), 100 ohm, tested to 500Mhz minimum. Provide four each individually twisted pair, 24 AWG conductors, Category 5e, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular intervals not to exceed 3 feet. The word "FEET" or the abbreviation "FT" shall appear after each length marking. Provide communications general purpose (CM or CMG), communications plenum (CMP) or communications riser (CMR) rated cabling in accordance with NFPA 70. Type CMP and CMR may be substituted for type CM or CMG and type CMP may be substituted for type CMR in accordance with NFPA 70.

2. Work Area Cabling & Patch Cables

    1. Work Area Copper - Provide pre-connectorized work area copper cable and patch cables in accordance with EIA TIA/EIA-568-C.2, with a blue thermoplastic jacket, compliant with same specifications as Horizontal Copper cabling above.

D. Coaxial Cabling - Cable shall be RG-6/U, quad shield. Cable shall be label-verified. Cable jacket shall be factory marked at regular intervals identifying cable type. Cable shall be rated CMP, CMR, or CMG as required by NFPA 70 for the application it is used in. Interconnecting cables shall be cable assemblies consisting of RG-6/U coaxial cable with male connectors at each end, provided in lengths determined by equipment locations as shown.

2.05 TELECOMMUNICATIONS SPACES

A. Provide connecting hardware and termination equipment in the telecommunications entrance facility and telecommunication equipment room to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with EIA TIA/EIA-606-A.

B. Building Protector Assemblies - Provide self-contained 5 pin or screw type unit supplied with a field cable stub factory connected to protector socket blocks to terminate and accept protector modules. Building protector assembly shall have interconnecting hardware for connection to interior cabling at full capacity. Provide manufacturers instructions for building

protector assembly installation. All pairs shall be terminated.

C. Protector Modules - Provide in accordance with UL 497 solid state type 5 pin or screw type rated for the application. Provide the number of surge protection modules equal to the number of pairs of exterior cable of the building protector assembly.

D. Backboards - Provide plywood 3/4 inch thick 4 by 8 feet. Backboards shall be fire rated. Do not cover the fire stamp on the backboard.

E. MDF Cabinet - Provide in accordance with EIA-310-D and UL 50. Provide a double-hinged wall-mounted type, Hoffman or equal. Cabinet shall have 16 gauge steel or 11 gauge aluminum construction , minimum, treated to resist corrosion. Cabinet shall have have lockable doors, louvered side panels, 250 CFM roof mounted fan, ground lug, and top and bottom cable access. Cabinet shall be compatible with 19 inch panel mounting. All cabinets shall be keyed alike. A surge protected power strip with 6 duplex 20 amp receptacles shall be provided within the cabinet. Provide cable management and a patch cable for each switch port. See patch panel requirements below. Provide a managed Ethernet switch and a security appliance:

1. Managed Ethernet Switch – the Ethernet switch shall be rack-mount, 52 port 10/100 with Gigabit uplinks and a minimum of 24 simultaneous POE ports. The switch shall support Layer 3 routing and a minimum of (5) VLANs. The switch shall be Cisco Small Business series (or equal) with a minimum of (4) fiber SFP ports. Contractor may need to provide a second switch to accommodate all four required fiber connections simultaneously. Provide single-mode SFP transceivers and matching standalone transceivers to be mounted in the SCADA panels. Coordinate with SCADA contractor.

2. Security Appliance – Provide Cisco ASA-5506-X or equal with appropriate licensing for a minimum of (3) simultaneous VPN connections.

3. ISP Modem – Coordinate with ISP to relocate existing ISP modem to the new MDF and configure for proper operation with the new security appliance. Obtain a static IP for the facility.

F. Connector Blocks - Provide insulation displacement connector (IDC) Type 110 for Category 5e and higher systems. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

G. Cable Guides - Provide cable guides, ring or bracket type, specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically on 19 inch equipment racks, cabinets, and telecommunications backboards.

H. Patch Panels - Provide ports for the number of horizontal and backbone cables terminated on the panel plus 25 percent spare. Provide pre-connectorized patch cords for patch panels. Provide patch cords, as complete assemblies, with matching connectors as specified. Provide fiber optic patch cables with crossover orientation in accordance with EIA TIA/EIA-568-C.3. Patch cords shall meet minimum performance requirements specified in EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2 and EIA TIA/EIA-568-C.3 for cables, cable length and hardware specified.

1. Modular to 110 Block Patch Panel - Provide in accordance with EIA TIA/EIA-568-C.1 and EIA TIA/EIA-568-C.2. Panels shall be third party verified and shall comply with EIA/TIA Category 5e and Category 6 requirements. Panel shall be constructed of 0.09 inch minimum aluminum and shall be mounted and compatible with an EIA-310-D 19 inch equipment rack. Panel shall provide 48 non-keyed, 8-pin modular ports, wired to T568B. Patch panels shall terminate the building cabling on Type 110 IDCs and shall utilize a printed circuit board interface. The rear of each panel shall have incoming cable strain-relief and routing guides. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

2. Fiber Optic Patch Panel - Provide panel for maintenance and cross-connecting of optical fiber cables. Panel shall be constructed of 16 gauge steel or 11 gauge aluminum minimum and shall be wall mounted. Each panel shall include single-mode adapters. Provide dust cover for unused adapters. The rear of each panel shall have a cable management tray a minimum of 8 inches deep with removable cover, incoming cable strain-relief and routing guides. Panels shall have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter.

2.06 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

A. Outlet/Connector Copper - Outlet/connectors shall comply with FCC Part 68EIA TIA/EIA-568-C.1, and EIA TIA/EIA-568-C.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing, third party verified, and shall comply with EIA TIA/EIA-568-C.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or exceed the requirements for the

cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired T568B. UTP outlet/connectors shall comply with EIA TIA/EIA-568-C.2 for 200 mating cycles. UTP outlet/connectors installed in outdoor or corrosive environments shall be jell-filled type containing an anti-corrosive, memory retaining compound.

B. Cover Plates - Telecommunications cover plates shall comply with UL 514C, and EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, EIA TIA/EIA-568-C.3; flush design constructed of 302 stainless steel to match color of receptacle/switch cover plates specified in Section 16140. Provide labeling in accordance with the paragraph LABELING in this section.

C. Coaxial Cable outlets shall be equipped with a female connector to accept the connecting coaxial cable from the user's video equipment. Faceplates provided shall be impact resistant plastic of the same color as the receptacles.

2.07 GROUNDING AND BONDING PRODUCTS

A. Provide in accordance with UL 467, TIA J-STD-607-A, and NFPA 70. Components shall be identified as required by EIA TIA/EIA-606-A

2.08 FIELD FABRICATED NAMEPLATES

A. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125 inch thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be 1 by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.09 TESTS, INSPECTIONS, AND VERIFICATIONS

A. Factory Reel Tests - Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.3, and EIA TIA/EIA-526-14A for multimode optical fiber cables.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install telecommunications cabling and pathway systems, including the horizontal and exterior cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, EIA TIA/EIA-568-C.3, EIA TIA/EIA-569-A, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Sections 16130 and 16131. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling shall be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment. All cable should be installed in a neat and workmanlike manner.

B. Cabling – Install UTP and optical fiber telecommunications cabling system as detailed in EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, EIA TIA/EIA-568-C.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

1. Open Cable - Use only above tile ceilings. Install in accordance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2 and EIA TIA/EIA-568-C.3. Do not exceed cable pull tensions recommended by the manufacturer. Copper cable not in a wireway or pathway shall be suspended a minimum of 8 inches above ceilings by cable supports no greater than 60 inches apart. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.

2. Exterior Cable

a. Copper Cable - Install intrabuilding phone copper cable, in indicated pathways.

b. Optical fiber Cable. Install intrabuilding optical fiber in indicated pathways. Do not exceed manufacturer's recommended bending radii and pull tension. Prepare cable for pulling by cutting outer jacket 10 inches leaving strength members exposed for approximately 10 inches. Twist strength members together and attach to pulling eye. Vertical cable support intervals shall be in accordance with manufacturer's recommendations.

3. Horizontal Cabling - Install horizontal cabling as indicated on drawings between the campus distributor, building distributors, floor distributors, and the telecommunications outlet assemblies at workstations.

C. Pathway Installations - Provide in accordance with EIA TIA/EIA-569-A and NFPA 70. Provide building pathways as specified herein and in Section 16130.

D. Work Area Outlets

1. Terminations - Terminate UTP cable in accordance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2 and wiring configuration as specified. Terminate fiber optic cables in accordance with EIA TIA/EIA-568-C.3.

2. Cover Plates - As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3. Cables - Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

4. Pull Cords - Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

E. Telecommunications Space Termination - Install termination hardware required for Category 5e and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation

displacement connectors.

1. Connector Blocks - Connector blocks shall be mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with EIA TIA/EIA-569-A.

2. Patch Panels - Patch panels shall be mounted with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

    a. Copper Patch Panel - Copper cable entering a patch panel shall be secured to the panel with cable ties or as recommended by the manufacturer to prevent movement of the cable.

    b. Fiber Optic Patch Panel - Fiber optic cable loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3. Equipment Support Frames - Install in accordance with EIA TIA/EIA-569-A. Mount cabinet so height of highest panel does not exceed 78 inches above floor.

F. Electrical Penetrations - Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 16010.

G. Grounding and Bonding - Provide in accordance with TIA J-STD-607-A and NFPA 70. Provide a #2 AWG insulated isolated ground conductor from the service entrance ground point to the backboard or cabinet/rack where terminal equipment is to be located. The Contractor shall be responsible for this installation, and the conductor shall terminate on an isolated ground bus, 12 inches in length, equal in capacity to the #2 conductor.

H. Surge Protection - All cables and conductors, except fiber optic cable, which serve as communication lines through off-premise lines, shall have surge protection installed at each end which meet the requirements of RUS Bul 1751F-815.

3.02 LABELING

A. Labels - Provide labeling in accordance with EIA TIA/EIA-606-A. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using thermal ink transfer process (such as a Brady labeler) or a laser printer.

B. Cables shall be labeled using color labels on both ends with identifiers in accordance with EIA TIA/EIA-606-A.

C. Termination Hardware - Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with EIA TIA/EIA-606-A.

3.03 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces. Painting shall be as specified in Division 9.

3.04 FIELD FABRICATED NAMEPLATE MOUNTING

A. Fasten nameplates to the device with a minimum of two stainless steel machine screws or rivets. On NEMA 4X cabinets, provide stainless sealing washers to prevent water entry.

3.05 TESTING

A. Telecommunications Cabling Testing - Perform telecommunications cabling inspection, verification, and performance tests in accordance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, and EIA TIA/EIA-568-C.3 where applicable. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests.Remove failed cable reels from project site upon attenuation test failure.

1. Inspection - Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568B pin assignments, and inspect cabling connections to confirm compliance with EIA TIA/EIA-568-C.1, EIA TIA/EIA-568-C.2, and EIA TIA/EIA-568-C.3. Visually confirm Category 5e and Category 6 marking of outlets, cover plates, outlet/connectors, and patch panels.

2. Verification Tests - UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in

connection blocks. Test cables after termination but not cross-connected. For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with EIA TIA/EIA-568-C.3 and EIA TIA/EIA-526-14A using Method A, Optical Power Meter and Light Source for optical fiber. Perform verification acceptance tests.

3. Performance Tests - Perform testing for each outlet and MUTOA as follows:

    a. Perform Category 5e link tests in accordance with EIA TIA/EIA-568-C.1 and EIA TIA/EIA-568-C.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay and delay skew.

    b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with EIA TIA/EIA-568-C.3.

    c. Coaxial cable system - After installation of the cable and before connecting system components, each cable section shall be end-to-end tested using a time domain reflectometer (TDR) to determine shorts, opens, kinks, and other impedance discontinuities and their locations. Cable sections showing adverse impedance discontinuities (greater than 6 dB loss) shall be replaced at the Contractor's expense.

4. Final Verification Tests - Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

    a. Voice Tests - These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

    b. Data Tests - These tests assume the network is installed and is available for testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

    c. Video Tests - Equipment and systems shall be tested demonstrating that the coaxial cable premises distribution system conforms to the specified requirements, and that the required equipment and systems are entirely operational.

-- End of Section --

SECTION 16726

LIFE SAFETY ALARM SYSTEM-ADDRESSABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work covered by this section of the Specifications includes the furnishing of all labor, equipment, materials, and performance of all operations associated with the installation of the Life Safety Alarm System for the Chemical Building as shown on the Drawings and as herein specified. The Alarm System shall satisfy the requirements of the Kentucky Building Code for an Emergency Alarm System as required for the detection and notification of a chlorine gas leak condition.

B. The requirements of the conditions of the Contract, Supplementary Conditions, and General Requirements apply to the work specified in this section.

C. The complete installation shall conform to the applicable sections of the National Electrical Code and any local codes required by the Authority Having Jurisdiction (AHJ). Contractor is required to communicate with and obtain approval from the AHJ prior to commencing construction or procurement of the alarm system.

D. All new systems furnished under this Contract shall be the same brand.

E. Two years of UL listed monitoring shall be included starting from the date of alarm system commissioning.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Division 16

1.03 QUALITY ASSURANCE

A. Each and all items of the Alarm System shall be listed as a product of a SINGLE alarm system manufacturer under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "UL" label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.

B. All control equipment must have transient protection to comply with UL 864 requirements.

C. Where Alarm circuits leave the building, additional transient protection must be provided for each circuit. Devices must be UL listed under standard #497B (Isolated Loop Circuit Protectors).

D. In addition to the UI- UOJZ requirement mentioned above, the system controls shall be UL listed for Power Limited Applications and all circuits must be marked in accordance with NEC Article 760-23.

1.04 GENERAL

A. Furnish and install a complete Alarm System as described herein and as shown on the Drawings, to be wired, connected, and left in first class operating condition. Include sufficient control panels, manual stations, ZAM/monitor modules, alarm indicating appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system. This includes all modules needed in the Life Safety Control Panel (LSCP) for operations as specified.

B. The alarm system shall allow for loading and editing special instructions and operating sequences as required. The system shall be capable of onsite programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the alarm control panel. Loss of primary and secondary power shall not erase the instructions stored in memory.

C. Full flexibility for selective input/output control functions based on ANDing, ORing, NOTing, timing, and special coded operations shall also be incorporated in the resident software programming of the system.

D. Resident software shall allow for full configuration of initiating circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, sensing or normally open contact devices to sensing of normally closed contact devices, or from sensing or normally open contact devices to sensing a combination of current limited and non-current limited devices on the same circuit and being able to differentiate between the two, or changing from a non-verification circuit to a verification circuit or vice-versa.

E. Resident software shall also allow for configuration of indicating appliance and control circuits so that additional hardware shall not be necessary to accommodate changes in, for instance, changing a non-coded indicating appliance circuit to a coded circuit, or from a slow march time (20 BPM) to a fast march time (120 BPM).

F. The system shall have the capability of recalling alarms and trouble conditions in chronological order for the purpose of recreating an event history.

G. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer’s name on each component. Acceptable manufacturers are Notifier, EST, Fike, or equal. Proprietary systems will not be accepted. If there are not at least (2) independent manufacturer partners with 150 miles of the project site then the system will be considered proprietary and will not be accepted.

H. Verification of Dimensions

1. The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall advise the A/E of any discrepancy before performing the work.

1.05 OPERATION

A. The following description sets forth the minimum requirements of the alarm system. Some operational features described herein may not be utilized at this time, but the system shall have the capability.

B. The system alarm operation subsequent to the alarm activation of any manual station or automatic detection device shall be as follows:

1. All audible alarm indicating appliances shall sound a march time pattern until silenced by the alarm silence switch at the control panel.

2. All visible alarm indicating appliances shall flash continuously until the system is reset.

3. The alarm condition shall be logged to the alarm Historical Log for future recall and review by the Owner's operator. Refer to Control Panel operations for full logging details.

4. Any subsequent zone alarm shall reactivate the alarm indicating appliances.

5. All doors normally held by door control devices shall release.

6. The mechanical controls shall activate the air handling systems in accordance with NFPA 90A.

7. Upon reset of the Life Safety control panel, air handling systems shall sequentially start up to minimize power demand.

8. The alarm shall be displayed on an 80 character LCD display. The top line of 40 characters shall be the point label and the second line shall be the device type identifier. The system alarm LED shall flash on the control panel until the alarm has been acknowledged. Once acknowledged, this same LED shall latch on. A subsequent alarm received from another zone shall flash the system alarm LED on the control panel. The LCD display shall show the new alarm information. To accommodate and facilitate job site changes, the 40 character custom label shall be on-site programmable by local service personnel.

9. A pulsing alarm tone shall occur within the control panel until the event has been acknowledged.

10. The control panel shall have the capability to display the number of times (tally) a zone has gone into a verification mode. Should this smoke verification tally reach a pre-programmed number, a trouble condition shall occur.

11. Alarm verification zones shall be able to be divided into 8 separate groups whereby only verification zones from the same group will confirm the first activation and cause the alarm sequence to occur.

12. The control panel shall have a dedicated supervisory service LED and a dedicated supervisory service acknowledge switch.

13. A manual evacuation (drill) switch shall be provided to operate the alarm indicating appliances without causing other control circuits to be activated. However, should a true alarm occur, all alarm functions would occur as described previously.

14. Activation of an auxiliary bypass switch shall override the selected automatic functions.

15. The system shall have a single key that will allow the operator to display all alarms, troubles, and supervisory service conditions including the time of each occurrence.

16. All doors normally held open by door control devices shall release upon AC power failure.

17. The actuation of the “enable walk test” program at the control panel shall activate the “Walk Test” mode of the system which shall cause the following to occur:

    a. Control relay functions shall be bypassed.

    b. The control panel shall show a trouble condition.

    c. The alarm activation of any initiation device shall cause the audible signals to activate for 2 seconds.

    d. The panel shall automatically reset itself after signaling is complete.

    e. Any momentary opening of an initiating or indicating appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating a trouble condition.

    f. The system shall have the capacity of 8 distinctive walk test groups, such that only a portion of the system need be disabled during testing.

g. Bypass the digital communicator circuit.

1.06 SUPERVISION

A. The system shall contain a minimum of 2 Class “B: (Style “B”) independently supervised initiating device circuits. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit.

B. There shall be a minimum of 4 independently supervised and independently fused indicating appliance circuits for alarm speakers and flashing alarm lamps. Disarrangement conditions of any circuit shall not affect the operation of other circuits.

C. Auxiliary manual controls shall be supervised so that an “off normal” position of any switch shall cause an “off normal” system trouble.

D. Each independently supervised circuit shall include a discrete LCD readout to indicate disarrangement conditions per circuit.

E. The incoming power to the system shall be supervised so that any power failure must be audibly and visually indicated at the control panel. A green “power on” LED shall be displayed continuously while incoming power is present.

F. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be audibly and visually indicated at the control panel.

G. The System Modules shall be electrically supervised for module placement. Should a module become disconnected, the system trouble indicator shall illuminate and the audible trouble signal shall sound.

H. The system shall have provisions for disabling and enabling all circuits individually for maintenance or testing purposes.

1.07 POWER REQUIREMENTS

A. The control panel shall receive 120 VAC power (as noted on the Drawings) via a circuit breaker. The Contractor shall label the breaker and furnish and install a locking device.

B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 4 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Substantiating battery calculations shall be submitted for supervisory and alarm power

requirements. Ampere- hour requirements for each system component and each panel component shall be submitted with the calculations.

C. All external circuits requiring system operating power shall be 24VDC and shall be individually fused at the control panel.

1.08 SUBMITTALS

A. Shop Drawings

1. Shop drawings shall be submitted in accordance with General and Special Conditions and shall consist of a complete set of equipment and materials, including manufacturer's descriptive and technical literature; performance charts and curves; catalog cuts; and installation instructions. Shop Drawings shall also contain complete wiring and schematic diagrams and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationships to other parts of the work including clearances for maintenance and operation. A floor plan drawing indicating alarm devices and wiring only shall be submitted by the Contractor for job site use. These drawings must be approved by the State Fire Marshal's Office. The Contractor is responsible for paying any fees and for obtaining State approval of the Alarm System. The Contractor shall submit Shop Drawings, including wiring schematics and floor plans, to the Engineer for acceptance prior to making submittal to DHBC for approval. A copy of the approval shall be sent to the A/E once obtained. The Contractor's submittal shall be signed by a registered NICET alarm designer who is regularly engaged in alarm system design.

B. The Contractor shall furnish 3 Operation and Maintenance manuals to be turned over to the Owner upon acceptance of the installation. Each manual shall be bound in a hard cover 3-ring binder, and indexed based on the CSI standard. The index shall include vendors name, address, and telephone number for all equipment purchased on the project.

C. The Operation and Maintenance manuals shall contain copies of the State approved Shop Drawings, manufacturer's operating and service manuals, parts lists, and manufacturer's warranty listing the Owner by name. If the service manual from any one vendor covers several different model numbers, the model used on the project must be highlighted. The binders shall not be more than 2/3 full; if so, additional binders shall be furnished. Final payment to the Contractor will not be made until Maintenance Manuals have been received and accepted.

D. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature.

PART 2 - PRODUCTS

2.01 LIFE SAFETY CONTROL PANEL

A. Control Panel construction shall be modular with solid state, microprocessor based electronics. It shall display only those primary controls and displays essential to operation during an alarm condition. Keyboards or keypads shall not be required to operate the system during alarm conditions. A local audible device shall sound during Alarm, Trouble or Supervisory conditions. This audible device shall sound differently during each condition to distinguish one condition from another without having to view the panel. This audible device shall also sound during each keypress to provide an audible feedback to ensure that the key has been pressed properly.

B. The following primary controls shall be visible through a front access panel:

1. Eighty character liquid crystal display
2. Individual red system alarm LED
3. Individual yellow supervisory service LED
4. Individual yellow trouble LED
5. Green “power on” LED
6. Alarm acknowledge key
7. Supervisory acknowledge key
8. Trouble acknowledge key
9. Alarm silence key
10. System reset key

C. The following secondary control switches and LED’s shall be available behind an access door:

1. Manual evacuation (drill)
2. Elevator bypass
3. Door holder release bypass
4. Future

D. The control panel shall provide the following:

1. Setting of time and date
2. LED testing
3. Alarm, trouble, and abnormal condition listing
4. Enabling and disabling of each monitor point
5. Activation and deactivation of each control point separately
6. Changing operator access levels
7. Walk test enable
8. Running diagnostic functions
9. Displaying software revision level

10. Displaying historical logs
11. Displaying card status
12. Point listing

E. For maintenance purposes, the following lists should be available from the point lists menu:

1. All points lists by address
2. Monitor point list
3. Signal/speaker list
4. Auxiliary control list
5. Feedback point list
6. Pseudo point list
7. LED/switch status list

Scrolling though menu options or lists shall be accomplished in a self-directing manner in which prompting messages shall direct the user. These controls shall be located behind an access door.

F. Primary Keys, LED's and LCD Display

1. The Control Panel shall have a 2 line x 40 character liquid crystal display which shall be backlit for enhanced readability. So as to conserve battery standby power, it shall not be lit during an AC power failure unless an alarm condition occurs or there is keypad activity.

2. The display shall support both upper and lower case letters. Lower case letters shall be used for softkey titles and prompting the user. Upper case letters shall be used for System Status Information. A cursor shall be visible when entering information.

2.02 SYSTEM FRONT PANEL OPERATION AND CAPABILITIES

A. Under normal condition, the front panel shall display a "System is Normal" message and the current time and date.

B. Should an abnormal condition be detected, the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The panel audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

C. The LCD shall display the following information relative to the abnormal condition of a point in the system.
1. 40 character custom location label
2. Type of device (i.e. smoke, pull station, waterflow)
3. Point status (i.e. alarm, trouble)

D. Abnormal conditions shall be acknowledgeable from the keypad.

These acknowledge functions may be passcode protected if the user has insufficient privilege to acknowledge such conditions. A message shall indicate insufficient privilege but allow the user to view the points without acknowledging them. Should the user have sufficient privilege to acknowledge, a message will be displayed informing the user that the condition has been acknowledged.

E. After all points have been acknowledged, the LEDs shall glow steady and the Sonalert will be silenced. The total number of alarms, supervisory and trouble conditions shall be displayed along with a prompt to review each list chronologically. The end of the list shall be indicated by an end of list message "END of LIST."

F. Alarm Silencing

1. Should the "Alarm Silence" button be pressed, all alarm signals shall cease operation.

2. Signals shall not be silenced during alarm silence inhibit mode.

G. System Reset

1. The SYSTEM RESET button shall be used to return the system to its normal state after an alarm condition has been remedied. The LCD display shall step the user through the reset process with simple English Language messages. Messages, "SYSTEM RESET IN PROGRESS," will first be displayed followed by the message, "SYSTEM RESET COMPLETED," and finally, "SYSTEM IS NORMAL," should all alarm conditions be cleared.

2. Should an alarm condition continue to exist, the message "SYSTEM RESET IN PROGRESS," will be followed by the message, "SYSTEM RESET ABORTED," and the system will remain in an abnormal state. System control relays shall not reset. The Sonalert and the Alarm LED will be on. The display will indicate the total number of alarms and troubles present in the system along with a prompt to use the ACK keys to review the points. These points will not require acknowledgment if they were previously acknowledged.

3. Should the Alarm Silence Inhibit function be active, the (SYSTEM RESET) key press will be ignored. The message, "SYSTEM RESET INHIBITED," will be displayed for a short time to indicate the action was not taken. As feedback to the operator, the message "SYSTEM RESET NO LONGER INHIBITED" will be displayed when the inhibit function times out.

H. Function Keys: Additional function keys shall be provided to access status data for the following points:

1. Initiating device circuits
2. Indicating appliance circuits

3. Auxiliary relays
4. Feedback points
5. All other input/output points

The following status data shall be available:

6. Primary state of point
7. Zone, PID and card type information
8. Class “A” status
9. Current priority of outputs
10. Disable/enable status
11. Verification tallies of initiating devices
12. Automatic/manual control status of output points
13. Acknowledge status
14. Relay status

I. History Logging

1. The system shall be capable of logging and storing 300 events in an alarm log and 300 events in a trouble log. These events shall be stored in a battery protected random access memory. Each recorded event shall include the time and date of that event’s occurrence.

2. The following Historical Alarm log events shall be stored:

   a. Alarms
   b. Alarm acknowledgment
   c. Alarm silence
   d. System reset
   e. Alarm historical log cleared

J. The following Historical Trouble Log events shall be stored:

1. Trouble conditions
2. Supervisory alarms
3. Trouble acknowledgment
4. Supervisory acknowledgment
5. Alarm verification tallies
6. Walk test results
7. Trouble historical log cleared
8. Silent walk test with history logging

K. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. The panel shall automatically reset itself after logging of the alarm.

L. The momentary disconnection of an initiating or indicating device circuit shall be silently logged as a trouble condition in the historical data file. The panel shall automatically reset itself after logging of the trouble condition.

M. Should the walk test feature be on for an appropriate amount of time (8 hours), it shall revert to the normal mode automatically.

N. The control panel shall be capable of supporting up to 8 separate testing groups whereby one group of points may be in a testing mode and the other (non-testing) groups may be active and operate as programmed per normal system operation. After testing is considered complete, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.

O. Should an alarm condition occur from an active point, not in walk test mode, it shall perform operations described in Section 1.04.

P. LED Supervision

1. All sleeve module LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the module and LED location number to facilitate location of that LED.

Q. System Trouble Reminder

1. Should a trouble condition be present within the system and the audible trouble signal silenced, the trouble signal shall resound at the preprogrammed time intervals to act as a reminder that the alarm system is not 100 percent operational. Both the time interval and the trouble reminder signal shall be programmable to suit the Owner's application.

R. Access Levels

1. There shall be 4 access levels with level 4 being the highest level. Level 1 actions shall not require a passcode. Passcodes shall consist of up to 10 digits. Changes to passcodes shall only be made by authorized personnel.

2. In order to maintain security when entering a passcode, the digits entered will not be displayed but a cursor will move along filling the position with an X to indicate that the digit has been accepted. All key presses will be acknowledged by a local audible sound.

3. When a correct passcode is entered, the message, "Access Granted" shall be displayed. The new access level shall be in effect until the operator manually logs out or the keypad has been inactive for 10 minutes.

4. Should an invalid code be input, the operator shall be notified with the message, "ERROR... INCORRECT PASSCODE," and shall be allowed up to 3 chances to enter a valid code. After 3 unsuccessful tries, the message,

"ACCESS DENIED," shall be displayed. The level shall not be altered, and the operator shall no longer be in the menu option.

5. Access to a level will only allow the operator to perform all actions within that level plus all actions of lower levels, not higher levels.

6. The following keys/switches shall have access levels associated with them:

   a. Alarm Silence
   b. System Reset
   c. Set Time/Date
   e. On/Off/Auto Control
   f. Disable/Enable
   g. Clear Historical Alarm Log
   h. Clear Historical Trouble Log
   I. Walk Test
   j. Change Alarm Verification

7. Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an (ACK) key with insufficient access, an error message will be displayed. The points will scroll with (ACK) key presses to view the points on the list, but the points will not get acknowledged in the database.

S. Communications Output – shall include capability to add a future Ethernet communication port.

T. Equipment Enclosures

1. Provide cabinets of sufficient size to accommodate the aforementioned equipment. Cabinet shall be equipped with locks and transparent door panel providing freedom from tampering yet allowing full view of the various lights and controls.

2.03 ADDRESSABLE NETWORK

A. Communication with Addressable Devices

1. The system must provide communication with initiating and control devices individually. All of these devices will be individually annunciated at the control panel. Annunciation shall include the following conditions for each point:

   a. Alarm
   b. Trouble
   c. Open
   d. Short
   e. Device missing/filed

B. All addressable devices shall have the capability of being disabled or enabled individually.

C. Up to 127 addressable devices may be multidropped from a single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable.

D. Systems requiring different circuits for various device types (i.e. smoke detectors on one circuit and pull stations on another circuit) shall not be acceptable. Systems requiring separate conduits for different circuits such as speaker circuits and addressable circuits shall not be acceptable.

E. Format

1. The communication format must be a completely digital poll/response protocol to allow t-tapping of the circuit wiring. A high degree of communication reliability must be obtained by using parity data bit error checking routines for address codes and check sum routines for the data transmission portion of the protocol. Systems that do not utilize full digital transmission protocol are not acceptable.

F. Identification of Addressable Devices

1. Each addressable device must be uniquely identified by an address code entered on each device at time of installation. The use of jumpers to set address will not be acceptable due to the potential of vibration and poor contact. Device identification schemes that do not use uniquely set addresses but rely on electrical position along the communication channel are unacceptable. These systems cannot accommodate t-tapping and the addition of an addressable device between existing devices requires reprogramming all existing electrically further devices. The system must verify that proper type device is in place and matches the desired software configuration.

G. Wiring Type, Distances, Survivability and Configurations

1. Wiring types will be approved by the equipment manufacturer. The system shall allow a line distance of up to 2,500 feet to the furthest addressable device on a Class B circuit. To minimize wire routing and to facilitate future additions, t-tapping of the communications channel will be supported.

H. Addressable Device Types

1. General

a. The system control panel must be capable for communicating with the types of addressable devices specified below. Addressable devices shall be located as shown on the Drawings.

2. Addressable Pull Stations

a. Addressable pull stations shall contain electronics that communicate the station's status (alarm, normal) to the transponder over two wires which also provide power to the pull station. The address shall be set on the station. They shall be manufactured from high impact red Lexan. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common to all system locks. Pull stations shall be double action.

b. The front of the station is to be hinged to a backplate assembly and must be opened with a key to reset the station. The key shall be common with the control panels. Stations which use Allen wrenches or special tools to reset, will not be accepted. The station shall consist of high impact Lexan plastic, red in color.

c. The addressable manual station shall be capable of field programming of its "address" location of an addressable initiating circuit. The manual station shall be fitted with screw terminals for field wire attachment.

d. There shall be no limit to the number of stations, detectors or Zone Adapter modules, which may be activated or "in alarm" simultaneously.

e. The addressable manual station shall be Underwriter's Laboratories, Inc. listed.

f. Emergency alarm pull stations shall be labeled "HazMat" or similar.

3. Zone Adapter Module (ZAM) (Monitor Module)

a. Zone Adapter Modules shall be used for monitoring of waterflow, valve tamper, Halon Control Panels, non-addressable detectors, and for control of evacuation indicating appliances and AHU systems.

b. An addressable interface module shall be provided for interfacing normally open direct contact devices to an addressable initiating circuit. the device shall be a Simplex type Zone Adapter Module (ZAM).

c ZAMs will be capable of mounting in a standard electric outlet box. ZAMS will include cover plates to allow surface or flush mounting.

ZAMs will receive their 24VDC power from a separate two wire pair running from an appropriate power supply.

d. There shall be 2 types of devices:

Type 1: Monitor ZAM
Type 2: Control ZAM

e. For Type 1 above:

(1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. This type of addressable device module will provide power to and monitor the status of a zone consisting of conventional 2-wire smoke detectors and/or N/O contact devices such as rangehood connections. The supervision of the zone wiring will be Class B. These ZAMs will communicate the zone's status (normal, alarm, trouble) to the transponder.

f. For Type 2 above:

(1) Zone Adapter Module for Non-supervised Control

(a) This type of addressable device will provide double pole, double throw relay switching for loads up to 120 VAC. It will contain an easily replaceable 2 amp fuse, one on each common leg of the relay. These ZAMs will be used for AHU shutdown. This will allow testing of duct smoke detectors without shutting down the Air Handling Units.

(b) The ZAM shall be supervised and uniquely identified by the control panel. Device identification shall be transmitted to the control panel for processing according to the program instructions. Should the ZAM become non-operational, tampered with, or removed, a discrete trouble signal, unique to the device, shall be transmitted to, and annunciated at, the control panel.

(c) The ZAM shall be capable of being programmed for its "address" location on the addressable device initiating circuit. The ZAM shall be compatible with addressable manual stations and addressable detectors on the same addressable initiating circuit.

4. Addressable Device Supervision

a. All devices shall be supervised for trouble conditions. The system control panel will be capable of displaying the type of trouble condition (open, short, device missing/failed).

b. Should a device fail, it will not hinder the operation of other system devices.

5. A Digital Communicator shall be included with the Life Safety Control Panel and wired to the panel for reporting alarms, trouble and supervisory signals to the UL listed central station digital receiver. The Contractor shall include the first year central station monitoring fee in his bid.

L. Alarm Signals

1. Provide speakers and visual alarm signals for all locations requiring wall mounted audio-visual alarm signals as shown on the Drawings. Any surface mounted speaker/visual unit will require backboxes and adapter plates.

2. Visual alarms should consist of White Xenon strobe units meeting ADA requirements, *75* candela minimum, 1-3 Hertz pulse rate, 0.2 second pulse duration.

3. Emergency alarm strobes shall have white paint with “Alert” text.

M. Remote Annunciator

1. Where shown on the drawings, provide and install 80 character backlit LCD display annunciator. The annunciator(s) shall have a brushed aluminum finish and provide one supervision lamp, one alarm lamp, and one trouble lamp per initiation device circuit. The annunciator shall communicate to the control panel over one twisted shielded pair of wire and operating power shall be 24 VDC and be fused at the control panel. Point-wired annunciators will not be considered as equal. The serial annunciator shall provide a common alarm and trouble circuit consisting of:

a. Control pushbutton switches for: Alarm silence, trouble silence, system reset and manual evacuation duplicating the control panel switches. A key “enable” switch shall be provided to activate or deactivate the control switches.

b. Tone Alert - Duplicates the control panel tone alert during alarm and trouble conditions.

N. Graphic Display

1. The graphic display shall have a plan view of the building floor. Each alarm zone shall be clearly labeled on the plans. Plan views shall be approximately to scale and in no case smaller than 18 inches wide or long. Provide display in a surface mounted enclosure with full size or plastic viewing plate. Enclosure shall have piano hinged door and key lock. See

drawings for additional requirements. The graphic display is required to be installed beside the remote annunciator. The graphic display is NOT required to be an electronic display.

2.06 SPECIAL TOOLS

A. Special tools necessary for the maintenance of the equipment shall be furnished. Two spare sets of fuses of each type and size required and *5* spare lamps and LED's of each type shall be furnished. Two percent of the total number of each detector, but no less than two each, shall be furnished. Fuses and lamps shall be mounted in the Life Safety Control Panel.

2.07 ALARM LOW VOLTAGE CABLES

A. Alarm Cables

1. All cables and conductors shall be installed in conduit.

B. Alarm Conductors (Conduit Use)

1. Conductors for use in conduit for alarm systems shall comply with NEC Article 760, and cables specified in B1 above may be used in conduit if so desired. Conductors and insulation types as specified for non-power limited protective signaling circuits in Article 760 may be used on power limited systems for this project in conduit. Conductors shall be rated 600 volts, UL listed, copper, minimum #16 AWG, but in no case smaller than recommended by the alarm manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION/APPLICATION/ERECTION

A. Furnish and install the system in accordance with the Drawings and Specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC Article 760 A and C, Power-Limited Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC Article 760 A and B. Upon completion, the Contractor shall so certify in writing to the Owner and general Contractor.

B. All alarm junction boxes shall be sprayed red and labeled "Life Safety Alarm." Wiring color code shall be maintained throughout the installation.

C. Installation of equipment and devices that pertain to other work in the Contract shall be closely coordinated with the appropriate subcontractors.

D. The Contractor shall clean all dirt and debris from the inside and the outside of the alarm equipment after completion of the installation.

E. The manufacturer's authorized representative shall provide on-site supervision of installation.

F. Grounding shall be provided to building ground.

3.02 TESTING

A. The completed alarm system shall be fully tested by the Contractor in the presence of the Owner's representative and the state DHBC inspector. Upon completion of a successful test, the Contractor shall so certify in writing to the Owner.

3.03 OWNER TRAINING

A. The system manufacturer shall train the Owner's representative (operator) on the system operation: History Log review and use; switch operation and use; alarm review, reset and evacuation operations; systems drills; trouble review and reset operations. See Section 16010 for additional requirements.

3.04 WARRANTY

A. The Contractor shall warrant the completed alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of 1 year from the date of the completed and certified test.

B. The equipment manufacturer shall make available to the Owner a maintenance contract proposal to provide a minimum of 2 inspections and tests per year.

END OF SECTION

SECTION 16900

CONTROLS AND CONTROL PANELS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Equipment controls and control panels shall be as specified herein and as shown on the Contract Drawings.

1.02 RELATED WORK

A. Drawings and General and Supplementary Conditions of the Contract and Division 1 Specifications sections apply to this Section.

B. All motor controls, starters, pushbuttons, pilot lights, and other miscellaneous devices shall comply with Section 16440 – MOTOR CONTROL.

1.03 SUBMITTALS

A. Panel and enclosure plan and elevation drawings depicting all components and wiring duct

B. Complete wiring diagrams

C. Catalog cut-sheets on all components, with options clearly indicated and non-applicable items clearly excluded

D. Enclosure heat gain calculation – Shall indicate the maximum temperature inside the enclosure on a 100°F day taking into account heat losses and inefficiencies of all panel components. Heat gain shall include the effects of radiation (if located outside) and air-conditioners or ventilation fans. The maximum operating temperature of all major equipment and panel components shall be listed. The heat transfer calculation shall be based on the enclosure manufacturer's published heat transfer data. This manufacturer's data or curve shall be submitted with the calculation for review.

E. Shop Drawings shall be clearly marked and or highlighted as to which product, type, option, etc. is being submitted. Product literature with one or more styles / configurations for a single product shall have a written description of use for each of the styles / configurations represented on the literature.

F. O&M manuals shall be submitted in accordance with Section 16010. They shall include all field modifications made such that the wiring diagrams exactly match the field-installed equipment and control panels. They shall also include complete

cut-sheets, product data, operation, and maintenance information.

1.04 REFERENCES

A. NFPA 79 – All control panels shall comply with NFPA 79.

B. NEC – All control panels shall comply with NEC article 409.

C. UL508 – All control panels shall be listed to UL508 and shall bear the UL label.

1.05 GENERAL REQUIREMENTS

A. All control panels furnished under this Contract shall be manufactured in accordance with industry standards and as herein specified. The Contractor shall coordinate all subcontractors and vendors to ensure that the control panels are furnished and meet the requirements specified herein.

B. Control panels shall be as manufactured by ControlWorks, Inc., Quality Controls, ADGO, or other UL or ETL qualified panel vendor. Panel construction shall comply with OSHA requirements and shall be either UL or ETL listed.

C. Control panels to be furnished on this project shall be wired to function according to schematics shown on the Contract Drawings. All Control Panels shall be manufactured using “relay logic”, or PLCs (Programmable Logic Controllers) as shown on schematics (control circuits) located in the Contract Drawings. In addition to the requirements shown on the Contract Drawings, the panels shall adhere to additional requirements as written herein, and in the utilization equipment specifications.

D. All components shall be mounted with threaded screws to a subpanel inside the enclosure such that they are replaceable without removing the subpanel. All wiring must be stranded and protected by a circuit breaker. Supplementary circuit breakers may be utilized for circuits that require wiring smaller than 14 gauge. Wiring ducts for cable/conductor management are required to be utilized for routing of conductors and cables. Ducts are also required to be provided for field-wiring at the top and bottom of the panels. All field wires should terminate at a terminal strip upon entering the control panel enclosure.

E. Elementary control schematics and connection diagrams showing the spatial relationship of components and wiring shall be submitted for review. Also, a bill of materials, drawing of device arrangement on front, and enclosure fabrication drawings shall be submitted. Further, descriptive literature is required on all components. A copy of the as-built wiring diagrams and BOM shall be stored in a pocket inside the control panel enclosure.

F. Labels shall be installed on all wires, keynoted back to the elementary schematic or the connection diagram, and all terminals identified.

G. Short circuit ampacity: The minimum short circuit ampacity of the control panel shall be as follows:

1. 480V control panels: 42kA (unless indicated to be lower on the Drawings)

2. 208/240V control panels: 10kA

3. 120V control panels: 10kA

H. Controlled equipment shall restart automatically after a power outage is restored, unless specifically exempted by Engineer due to safety concerns.

PART 2 - PRODUCTS

2.01 ENCLOSURES

A. Control panel enclosure shall be wall-mount type where sized at 30” width x 42” height or less. Otherwise, it shall be floor-mount type. All panels indicated on the Drawings to be floor-mounted shall be floor-mounted regardless of size. Enclosures shall be single or double-door as required. Enclosure shall include a NEMA flange-mounted lockable disconnect for three-phase power supply, or an IEC style rotary lockable disconnect for single phase power supply. Enclosures shall be manufactured by Hoffman, or equal.

B. Enclosure NEMA rating shall be as indicated for the area on the Drawings. Enclosures to be located outside shall be NEMA 4X type 316 stainless. NEMA 1/12/4 enclosures shall be steel with ANSI 61 gray finish unless painting is required in Division 9. NEMA 4X enclosure material shall be stainless steel type 316, except in chemical areas, which shall be fiberglass-reinforced plastic. The enclosure shall be sized to provide 10% spare panel space. Seams shall be continuously welded and ground smooth.

C. Enclosure door shall have a 3-point latch. Screw clamps are not acceptable. The latch handle shall have a padlock hasp.

D. Enclosures to be installed outside shall have an interior dead-front swing out panel for panel-mounting of all pilot devices and displays. Operator devices shall not be mounted on the exterior of the enclosure, except for a single alarm strobe where indicated on the Drawings. The enclosure shall also have an interior pocket for holding wiring diagrams, and an interior sub-panel for mounting control equipment.

2.02 WIRING REQUIREMENTS

A. Wire and cable shall comply with Section 16120 except Type MTW conductors shall be used inside the control panel for control circuits. Control circuit wiring shall be 18 gauge or larger.

B. Control wiring shall be terminated using crimp-type ferrule, fork, or ring terminals. Power wiring shall utilize compression lugs.

C. Wiring shall extend to terminal blocks for connection to external equipment.

2.03 TEMPERATURE CONTROL DEVICES

A. Electric Heater for Control Panels

1. Provide an electric heater for exterior control panels
2. Heater shall be sized as indicated on the Contract Drawings, or shall be sized and submitted in the Enclosure Heat Gain calculation
3. The heater shall include an integral thermostat, adjustable from 0°F to 100°F, and a fan
4. Heater housing shall be anodized aluminum
5. Fan shall have ball bearings and shall be designed for continuous operation
6. Terminal strip shall accept both solid and stranded wire
7. The heater shall be UL Recognized and CSA listed
8. The heater shall be Hoffman's thermostatically controlled fan-driven heater, or equal.

B. Air Conditioners for Control Panels

1. Not applicable on this project. All control panels shall be designed to dissipate heat with fans and filtered louvers.

2.04 MOTOR CONTROLS

A. Starters

1. All magnetic starters and contactors shall be steel mounted, front wired with all terminals accessible for wiring directly from the front. Movable contact blocks shall depend on gravity only and not the use of springs for operation to the open position.

2. Starters shall be NEMA type and sized appropriately for the motor to be controlled, but in no case shall any starter or contactor be smaller than NEMA size 1 or smaller than as indicated on the Drawings. IEC starters are not acceptable.

3. All contactors shall be double break, solid silver cadmium oxide alloy, or equal. Bare copper or silver flashed copper contacts which require periodic filing or cleaning maintenance will not be permitted.

4. Operating coils shall be pressure molded and so designed that, if accidentally connected to excessive voltage they will not expand, bubble or melt. When a coil fails under and condition, the starter shall open and shall

not "freeze" in the closed (on) position. Coils shall be replaceable from the front of the starter without having to remove the starter from the panel or enclosure.

5. Combination starters shall be of the molded case circuit breaker type. Trip elements of multi-pole breakers shall be effectively insulated from one another. Multi-pole breakers shall be designed such that an overload on one pole opens all poles simultaneously. Breakers shall be quick-make, quick-break and shall be entirely trip free to prevent the contacts being held in a closed position against a short circuit. Breakers for full voltage starters shall be the magnetic only type. All others shall be thermal magnetic.

6. Each starter leg shall have a thermal overload device in each ungrounded leg. The overload shall be bimetal, ambient compensated, thermal element type. Solid state overload devices, are not acceptable. If the adjustable trip type are used, a lockable cover must be provided to prevent unauthorized adjustment.

B. Reduced Voltage Solid State Starters – See Section 16444.

C. Variable Frequency Drives – See Section 16483.

2.05 POWER SUPPLIES

A. DC Power Supplies

1. DC power supplies shall be switched mode and Din-rail mountable.
2. Input power range shall be from 85-264 VAC.
3. Output voltage range shall be as needed with a tolerance of 1%. Output voltage shall be adjustable up and down at least 10% from the nominal value.
4. The power supply shall include an internal input fuse.
5. Power supply shall have a “DC Ok” signaling LED.
6. Operating temperature rating shall be –25 C to +70 C and up to 95% relative humidity.
7. Output power shall be buffered for full output power ridethrough for 20 milliseconds in the event of a power outage.
8. The power supply shall be able to supply 150% of its continuous capacity for short periods of time.
9. The power supply shall have internal short circuit protection with automatic recovery.
10. The power supply shall be Phoenix Contact, Sola, Allen-Bradley, or equal.

2.06 OVERCURRENT PROTECTION

A. Main 3-Phase Breakers – Shall be thermal-magnetic, molded-case, Type FA or KA as needed, Square D or equal. Provide service entrance rating where

indicated on the Drawings as being used in a service entrance application. See short circuit rating requirements above. Provide cable assembly to connect to flange-mounted disconnect.

B. Main Single-Phase Breakers – Shall be Din-rail mountable with clear “on,” “off,” and “tripped” positions, Square D QOU or equal. Where a substantial number of breakers are used, provide a panelboard mounting base.

C. Combination Starters – Circuit breakers for use with combination starters shall be magnetic-only, Square D MagGuard, or equal, with adjustable trip settings.

D. Supplementary Protectors – Shall be Din-rail mountable UL489 listed. Trip rating shall match load served.

E. Power Fuses – Utilize Class J or CC fuses and fuse blocks. Fuse blocks must have protective cover. Fuses may only be used where indicated on the Drawings. Otherwise, use circuit breakers.

2.07 MISCELLANEOUS PANEL COMPONENTS

A. Terminal Blocks, #10 conductor size and smaller.

1. Terminal blocks shall be Din-rail mountable IEC style with minimum width of 6.2 mm. They shall be rated for conductors from #10 to #24 AWG. Current rating shall be 30A, minimum. Terminal blocks shall be finger-safe. Double level terminal blocks may be utilized where necessary to conserve space.
2. Screw clamp terminal blocks are required. Terminal blocks that rely upon spring pressure only for conductor termination are not acceptable.
3. Provide cross connection bridges, partition plates, end anchors, zack strip labels, and all other components necessary for a complete installation. Each block shall be labeled with a machine-printed label. No more than 2 conductors may be landed under on single terminal block terminal screw.
4. Utilize the following terminal block colors:
    a. 120V Power – Black
    b. 120V Control – Red
    c. 120V Neutral – White
    d. Equipment Grounding – Green or Green/Yellow
    e. DC Positive – Blue
    f. DC Negative/Grounded – Gray
    g. Conductor energized from remote source: Yellow
5. Terminal blocks shall be manufactured by Phoenix Contact, Allen-Bradley, or equal.

B. Fuse blocks (control circuits) – Fuse blocks shall be finger safe and shall have LED indication when the fuse is blown. Fuses may be used only where indicated on the Drawings; otherwise use circuit breakers.

C. Conductor Labels – Shall be the heat-shrink type, machine printed. Brady, or equal.

D. Component nameplates – Shall be engraved, rigid, laminated plastic with adhesive back and letter height of 3/16” minimum. Nameplates shall be white with black letters.

E. Intrinsic Safety Barriers – not applicable on this project.

F. Transient/Surge protectors shall comply with Section 16280.

G. Control transformers shall be machine tool type transformers with epoxy encapsulated coils or resin impregnated coils, high quality silicon steel laminations, copper magnet wire, molded-in terminals, and 55°C rise insulation system.

H. Voltage/Phase Monitor – Shall continually measure the voltage of all phases of incoming power and provide protection for any motors or other equipment that could be damaged. The phase monitor shall sense under and overvoltage, voltage unbalance, phase loss, and phase reversal. It shall have a relay output.

I. Pilot Devices

1. Selector switches shall be NEMA 4X, 30mm, oil-tight construction, and of the quick-make, quick-break type.

2. Pushbuttons shall be NEMA 4X oil-tight, 30mm.

3. Pilot lights shall be 30mm, oil-tight, push-to-test, NEMA 4X LED type. Green pilot lights shall be used for indicating “pump running,” and yellow shall be used for “seal leak.”

4. Elapsed time meters shall be non-resettable.

5. Timing relays shall have an adjustable time range suitable for the application, with the time delay occurring after energization.

J. Control Relays

1. Control relays shall be magnetic, general purpose, "ice cube" type with 3-pole (minimum), double throw contacts rated at 5 amperes (minimum), 120 volts (minimum). Coils shall be rated to operate at the indicated control voltage.

2. Provide proper bases, mounting track, etc. for a complete installation. All relays shall be have a retainer clip, manual operator, and pilot light. Coils connected to solid-state digital outputs shall have transient surge protection.

PART 3 - EXECUTION

3.01 LABELING

A. Provide labels for all conductors and components.

B. Legends for starter nameplates shall be taken from the one line diagram in the Contract Drawings. Wire and miscellaneous component labels shall match the O&M manual wiring diagrams.

3.02 GROUNDING

A. Enclosures shall be grounded in accordance with the NEC.

B. Each analog signal loop shall be grounded at a single point for the loop at the location of the DC power supply for the loop.

3.03 PROTECTION

A. All electrical and electronic components of the Control Panel shall be protected against damage due to electrical transients induced in interconnecting lines from lightning discharges and surges in nearby electrical systems. Provide a surge protection device (SPD).

B. All three-phase control panels with FVNR starters shall be equipped with a voltage/phase monitor. Panels with drives or soft-starters that have electronic fault protection against supply voltage problems are not required to have phase monitors.

3.04 INSTALLATION/ERECTION

A. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, manufacturer Shop Drawings, and manufacturer installation instructions.

END OF SECTION

SECTION 17010

GENERAL INSTRUMENTATION AND SCADA REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install all materials, services, spare parts, commissioning, and other services as shown and specified and as required to install a complete, functional, calibrated, instrumentation and supervisory control and data acquisition (SCADA) system as indicated on the Drawings and as described herein.

B. It also includes installation and connection of all instrumentation equipment, along with Scada connections to all equipment, included in this Contract but furnished by other contractors or suppliers.

C. All Instrumentation/Scada equipment shall be installed, connected, and left in operating condition. The number and size of cables and conductors between all equipment and Scada monitoring/control devices shall be as required to obtain the operation described in these Specifications, and/or by the Contract Drawings, and/or as shown in manufacturer-furnished, Engineer-reviewed Shop Drawings. The Contractor shall be responsible for supplying all components such as relays, loop isolators, transducers, etc., as necessary, whether indicated or not, at no additional cost to the Owner in order to leave a complete functional instrumentation system. The Contractor shall ensure compatibility between all system components and provide any necessary peripheral equipment as required to make the components compatible.

D. The Contractor shall be responsible for making any modifications to existing equipment, where required to accept new equipment and systems. If modifications are to be made to equipment that is still under warranty of a manufacturer that the Contractor is not authorized to perform service to, then the Contractor shall obtain the services of that equipment manufacturer's service personnel to perform the work under the supervision of the Contractor.

E. All devices and items of instrumentation/Scada equipment, including those shown on the Contract drawings but not specifically mentioned in these Specifications or those mentioned in these Specifications but not shown on the Contract drawings, are to be furnished under this division of the Specifications. Any such device or item of equipment, if not defined in quality, shall be equal to similar equipment and/or devices specified herein.

F. Where wiring diagrams are not shown on the Contract Drawings, they are to be furnished by the supplier of the equipment served and such diagrams shall be adhered to except as herein modified.

G. Bidders are required to visit the construction site prior to submitting a bid and carefully examine the Contract Drawings and Specifications so that he/she may fully understand what is to be done and to document existing conditions. Any discrepancies, questions, or omissions must be brought to the attention of the Engineer at least 10 days prior to the bid opening date. Extras will not be approved for work that the Contractor should have seen beforehand by visiting the site prior to bidding.

1.02 RELATED WORK

A. Contractors bidding work under this Contract shall read and understand Division Zero and Division 1 - General Requirements. If any discrepancies are discovered between the General Instrumentation and Supervisory Control and Data Acquisition (SCADA) Requirements and General Requirements, the above-mentioned documents shall overrule this section. The General Instrumentation/SCADA Requirements are intended as a supplement to the above-mentioned documents. The Contractor shall bid as outlined in the above mentioned Specifications and shall be governed by any alternates or unit prices called for in the form of proposal.

B. Division 16 - Electrical

1.03 SCADA SUPPLIER QUALIFICATIONS

A. The SCADA supplier must have an office with a minimum of (3) technical/programming personnel located within 200 miles of the project site.

B. The proposed project manager must normally work out of the local office and must hold an ABET-accredited engineering degree or a Computer Science degree from a 4-year university.

1.03 SUBMITTALS

A. Qualifications Submittal: This submittal shall be submitted within two weeks of Contract award. Bidders may also submit a pre-bid qualification submittal (minimum 10 days before bid opening) if the acceptability of the supplier is in doubt and an addendum will be issued. A résumé of the proposed project manager shall be submitted with a minimum of (3) project references that he/she was responsible for. Submittal shall include a description of the major equipment and software proposed for this project along with any material proposed deviations from these Specifications. Describe the SCADA supplier’s provisions for service, technical assistance and replacement parts for the proposed system. Submit résumés for at least two other programmers who are normally based in the local office.

B. Shop Drawings including descriptive literature and/or installation, operation and maintenance instructions shall be submitted in the amount of copies as listed in

the General Conditions, but no less than 8 copies. All Shop Drawings shall be submitted in loose-leaf three-ring cardboard reinforced vinyl binders with extensive indexing. Each sheet in the binder shall have hole reinforcements. Should there be any exceptions to the Specifications, the Supplier shall completely describe such in front of the submittal via a point-by-point letter referencing the specification paragraph number. The submittal shall be arranged as follows:

1. Front Cover – Project description and pertinent information
2. First Page – Review stamp page.
3. Next – Index
4. Next – Overall description of the system
5. Next – System architecture diagram with IP addressing
6. Next – Complete manufacturer's information on all equipment and software
7. Next – Complete manufactured drawings of control panels including a detailed point by point wiring diagram of each. Drawings shall be either 8.5"x11" or 11"x17". The first page of each product literature shall have the tag designation clearly indicated. Provide for each loop, the selected size of the equipment being submitted, NEMA classification, sizing calculations, and calibration data for all metering devices. Selected options shall be clearly indicated and excluded items shall be clearly marked out.
8. Next – Complete list of spare parts, training program outline, Warranty description and information.

C. Shop Drawings shall be submitted on all equipment specified in this Division unless a specific written exemption is obtained from the Engineer. The Contractor shall not procure or install any materials or equipment without approved shop drawings.

D. The Engineer reserves the right to make modifications to instrumentation & Scada equipment after Shop Drawing review, if the Instrumentation/Scada Shop Drawings are submitted prematurely (prematurely meaning submitted before all process equipment has been reviewed and accepted). Cost of modifications shall be the Contractor's responsibility.

E. Software Submittals: Provide communication and control database programs for project in hardcopy form. Software form is acceptable if the necessary software is provided to access the programs. Software shall be fully documented, including code, comments, addressing data and cross-references, etc. Every line or section of code shall be accompanied by a comment describing its function. Provide initial graphic display and report format layouts as described later in this specification. List and briefly describe all operator interface functions provided at the PC, including: alarm annunciation and acknowledgment, status displays, control capabilities, report generation, event logging, charting and trending, etc.

F. Operation & Maintenance: Manuals shall be accepted shop drawings with the following modifications:

1. Include complete addresses of all equipment manufacturing

representatives and phone numbers of each.

2. Incorporate complete record drawings indicating final installation of equipment and wiring.

3. Include complete manufacturer’s installation, operations, and maintenance manual for each piece of equipment and software supplied.

4. Complete parts lists with stock numbers.

5. Include a configuration record for each piece of equipment, including all parameter settings and set points.

6. Include NIST or other calibration certificates for Instrumentation.

7. The manuals shall include disks or thumb drives with the following saved information:

   a. Backup of all programs developed in the course of the project.
   b. Backup of all reports, databases, set point listings, and all other electronic information utilized in the project.
   c. Electronic copy of all installation, operations, and maintenance manuals which are available from the manufacturer in electronic format.

1.04 QUALITY ASSURANCE

A. The Contractor shall be a factory authorized representative capable of start-up services of the equipment or shall provide the services of a factory authorized representative.

B. The instrumentation/Scada system shall be furnished as an “open” system that can be modified and updated by the Owner or by any of the Owner’s designated representatives. Proprietary systems will not be considered. The Owner reserves the right to cancel any post-construction service contract at any time due to quality of service or any other reason as determined by the Owner.

C. In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service to the greatest extent possible, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

D. Software Progress Meetings: Allow in Bid for 1 meeting per month at Engineer's office in Lexington, KY, for review of PLC logic and graphic operator screens. Meetings to commence at time of initial software development kickoff and continue up to final completion. These meetings shall be for specific purpose of assuring that software development work is in accord with Contract requirements and are in addition to project progress meetings that may otherwise be required. If the software can be hosted on a website such that the Engineer can access the

logic and graphics, then the software progress meetings can be implemented via telephone or web conference.

1.05 SYMBOLS AND ABBREVIATIONS

A. The symbols and abbreviations generally follow standard instrumentation and electrical practice, however, exceptions to this shall be as shown on the Contract Drawings.

1.06 COORDINATION WITH OTHER TRADES

A. The Contractor shall coordinate the instrumentation/Scada work with that of other trades to ensure proper installation and functionality of all equipment and process control/monitoring programs. Installation of equipment may be performed by other trades unless specified otherwise.

1.07 CODES

A. The minimum standard for all work shall be the latest revision of the Kentucky Building Code (KBC), and the National Electrical Code (NEC). Whenever and wherever state and/or local laws or ordinances and/or regulations and/or the Engineer's design require a higher standard than these codes, then these laws and/or regulations and/or the design shall be followed.

B. Following is a list of other applicable Standards or Codes:

1.	Kentucky Building Code	KBC
2.	National Electrical Code	NEC
3.	International Electrotechnical Commission	IEC
4.	Underwriters Laboratories, Inc.	UL
5.	Factory Mutual System	FM
6.	National Fire Protection Association	NFPA
7.	National Electrical Manufacturers Association	NEMA
8.	Occupational Safety and Health Administration	OSHA
9.	National Institute of Standards and Technology	NIST
11.	Instrument Society of America	ISA
12.	Institute of Electrical and Electronic Engineers, Inc.	IEEE
14.	American National Standards Institute, Inc.	ANSI
16.	Joint Industry Council	JIC
17.	American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.	ASHRAE
18.	Federal Communications Commission	FCC
19.	American Society for Testing and Materials	ASTM

1.08 STORAGE

A. All work, equipment, and materials shall be protected against dirt, water, or other injury during the period of construction.

B. Sensitive instrumentation/Scada equipment shall be protected against injury or corrosion due to atmospheric conditions or physical damage by other means. Protection is interpreted to mean that equipment shall be stored under roof, in a structure properly heated in cold weather and ventilated in hot weather. Provision shall be made to control the humidity in the storage area to 50 percent relative. The stored equipment shall be inspected periodically, and if it is found that the protection is inadequate, further protective measures shall be employed. Instrumentation/Scada equipment shall not be installed until the structure is under roof with doors and windows installed.

1.09 ERRORS, CORRECTIONS, AND/OR OMISSIONS

A. Should a piece of process equipment be supplied of a different type or manufacture than shown or specified in the Contract documents, the Contractor shall be responsible for installing, programming, and commissioning the proper instrumentation/Scada equipment for proper operation, control, and monitoring of that process equipment at no extra cost to the Owner.

B. It is the intent of these Specifications to provide for an instrumentation/Scada system installation complete in every respect, to operate in the manner and under conditions as shown in these Specifications and on the Contract Drawings. The Contractor shall notify the Engineer, in writing, of any omission or error at least 10 days prior to opening of bids. In the event of the Contractor's failure to give such notice, he/she may be required to correct work and/or furnish items omitted without additional cost. The submission of a bid indicates that the Contractor believes the design to be sound and can provide a fully functional and complete instrumentation and SCADA system. Further requirements on this subject may be found in the General Requirements, Division 1.

1.10 GUARANTEES AND WARRANTIES

A. The Contractor shall guarantee all work including equipment, materials, and workmanship. This guarantee shall be against all defects of the electrical system or improper equipment operation. It shall last for the period of time specified in the General Conditions of the Contract, but not less than one year from the date of system acceptance (i.e. – when the Engineer accepts that the punchlist is complete.)

B. Return visits – the Contractor shall provide a minimum of three one-day return visits after final completion to implement additional software items as requested by the Owner. The costs for these return visits shall be included in the bid price.

C. A complete instrumentation service contract shall be furnished to the Owner from the Contractor or system supplier. The service contract shall include complete, labor, parts, expenses, and emergency calls providing on-site response within 24

hours. This contract shall be for a period of one year after final acceptance of the system. The costs for this contract shall be included in the bid price.

D. Equipment manufacturers shall provide a minimum of one-year of technical support and software updates dating from final acceptance. The costs of this shall be included in the bid Certification of this shall be provided to the Owner with the O&M manuals.

1.11 TESTING

A. After the instrumentation/Scada system is complete, and at such time as the Engineer may direct, the Contractor shall conduct an operating & performance test for acceptance. The system shall be demonstrated to operate in accordance with the requirements of these Specifications and the Contract Drawings. The test shall be performed in the presence of the Engineer or his authorized representative. The Contractor shall furnish all instruments, hardware, software, and personnel required for the tests.

1.12 UTILITY AND REGULATORY COORDINATION

A. The Contractor is responsible for coordinating all activities required by the necessary utilities and regulatory agencies. This includes obtaining Internet service for the site(s), coordinating IP addresses and domain names with the Internet service provider, and coordination with the wireless cellular provider.

B. Any special provisions required by the utilities or regulatory agencies shall be as outlined on the Contract Drawings or as advised by the utility at the time of construction, and work required by these special provisions shall be executed with no extra cost to the Owner.

C. Fees charged by the utilities and wireless providers shall be included in the Contractor’s lump sum bid.

1.13 TRAINING

A. All manufacturers supplying equipment for this division shall provide the Owner’s operations staff with training in the operation and maintenance on the equipment being furnished. The training shall be conducted at the project site by a qualified representative of the manufacturer.

B. The cost of this training shall be included in the bid price.

C. The required training shall consist of both classroom and hands-on situation. Classroom training shall include instruction on how the equipment works, its relationship to all accessories and other related units, detailed review of shop drawings, detailed presentation of written O & M instructions, troubleshooting and record-keeping recommendations. Hands-on-training shall include a review of the manufacturer’s O & M instructions, check out of each operator as to identifying

key elements of the equipment, tear down as appropriate, calibration, adjustment, and operating manipulations of all controls.

D. The training shall be scheduled through the Contractor with the Owner. The timing of the training shall closely coincide with startup of the equipment, but no training shall be conducted until the equipment is operational. The training program shall not begin until operations and maintenance manuals have been reviewed and sent to the Owner. Training shall use the accepted O & M manuals. Training shall not begin until the Contractor's instrumentation/Scada punchlist is completed and all loops have been calibrated and are fully operational.

E. The training program length shall be as described in the individual Division 17 sections.

F. At least 30 days prior to the training the manufacturer shall submit through the Contractor to the Engineer an outline of the training proposed for the Engineer's review and concurrence.

1.14 RECORD DRAWINGS

A. The Contractor shall maintain 1 set of the Contract Drawings on the job in good condition for examination at all times. The Contractor's qualified representative shall enter upon these drawings, from day to day, the actual record of construction and/or alteration progress. Entries and notes shall be made in a neat and legible manner and these drawings delivered to the Engineer after completion of the construction, for use in preparation of Record Drawings.

1.15 MAINTAINING CONTINUOUS PROCESS CONTROL AND MONITORING SYSTEM

A. Existing system(s) continuity shall be maintained at all times. In no way shall the installation and/or alteration of the instrumentation/Scada work interfere with or stop the normal operation of the existing facilities, except where prior arrangements have been made.

B. When additions and modifications to existing system(s) require outages of duration in excess of a few minutes, arrangements shall be made in advance for such outages. All outages shall be held to an acceptable minimum with none exceeding 8 hours continuous duration. If necessary, outages shall be performed on premium time. Under no circumstances shall a process control/monitoring outage of any duration be initiated until the Owner and Engineer have concurred, and as far as possible in advance.

1.16 RECEIPTS

A. Some sections of the Specifications call for equipment, materials, accessories, etc. to be furnished and "turned over to the Owner" or like requirements. The Contractor shall obtain a receipt for each item turned over, signed by the Owner or his representative. A copy of this receipt shall be transmitted to the Engineer.

B. When a question arises concerning whether items have been turned over to the Owner, and there is no signed receipt, it may be assumed that the items were not furnished.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials used shall be new unless noted otherwise. All materials shall be UL listed for the application, where a listing exists. Additional requirements are found in Division 1. All equipment shall meet applicable FCC requirements and restrictions.

B. The material and equipment described herein has been specified according to a particular trade name or make to set quality standards. However, each Contractor has the right to substitute other material and equipment in lieu of that specified, other than that specifically mentioned for standardization, providing such material and equipment meets all of the requirements of that specified and is accepted, in writing by the Engineer.

C. The reuse of salvaged equipment, control programs, or screen graphics will not be permitted unless specified herein or indicated on the Contract Drawings.

D. All salvaged or abandoned instrumentation/Scada materials shall become the property of the Contractor and removed from the project site, unless otherwise noted on the Contract Drawings or specified herein.

PART 3 - EXECUTION

3.01 GROUNDING AND BONDING

A. All metallic conduit, cabinets, supporting framework and instrumentation/Scada equipment shall be grounded in accordance with the latest issue of the National Electrical Code.

3.02 ANCHORING/MOUNTING

A. Instrumentation/Scada equipment other than computer equipment located in the office/control room shall be rigidly supported . Anchors used shall be metallic expansion type, or if appropriate to prevent spalling concrete, epoxy set type. Plastic or explosive type anchors are prohibited.

END OF SECTION

SECTION 17100

PROCESS INSTRUMENTATION

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide instrumentation as indicated on the Contract drawings. Provide all materials, labor, spare parts, start-up services, as shown and specified and as required to install a complete, functional, calibrated instrumentation system.

B. Provide surge protection on instrumentation loops and power supplies as specified herein.

C. Provide instrumentation training services.

D. Additional requirements are in Section 17010.

1.02 RELATED WORK

A. Installation of all electrical equipment, conductors, and related items shall be in accordance with all applicable sections of Division 16 of these specifications.

B. General Requirements are included in Division 1.

C. Division 11 – Equipment

D. Section 17010 - General Instrumentation and SCADA requirements.

1.03 SUBMITTALS

A. Shop drawing approval is required before the Contractor purchases or installs any equipment. Submit in accordance with Section 17010.

B. Operation and Maintenance Manuals shall be submitted in accordance with Section 17010.

1.04 QUALITY ASSURANCE

A. See Section 17010 for requirements.

B. Manufacturer NIST or equal calibration certificate is required for all instruments with an analog current or voltage signal output.

1.05 WARRANTY AND SERVICE

A. See Section 17010 for requirements.

1.06 SPARE PARTS

A. Ten fuses of each size/type in the system.

B. Provide calibration kits for all instruments where offered by the manufacturer.

1.07 TRAINING

A. Training shall be in accordance with Section 17010.

B. The instrumentation training program shall be a minimum of one 8 hour day on-site.

1.08 DELIVERY AND STORAGE

A. See Section 17010 for requirements.

PART 2 – PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers/suppliers for the instrumentation equipment shall be Rosemount, Foxboro, Endress-Hauser, ABB, or equal. Manufacturers of small peripheral equipment are listed with each piece of equipment.

B. All equipment shall be UL listed where a listing exists.

C. All electronic instrumentation equipment shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA dc. No zero based signals will be allowed for remote transmission.

D. All instrumentation supplied shall be of the manufacturer's latest design and be compatible for the industry it is being applied.

E. All scales and readouts shall be direct reading in process units. Conversions are not acceptable.

F. All transmitters shall be provided with indicators, either integral or remote mounted, but must be within site of the transmitter unless specifically indicated otherwise on the Contract drawings.

G. All equipment must be able to reset after a power outage without having to be manually reset.

H. All circuit boards in instruments mounted outdoors, or in damp locations, shall be fungus proofed.

I. All equipment mounted outdoors shall be protected from the sunlight, and extreme temperatures between –20 degrees and 140 degrees Fahrenheit. Provide all necessary shielding, heaters, or air conditioners as required. All externally mounted panels shall have self-sacrificing corrosion inhibitors installed.

2.02 INSTRUMENTATION EQUIPMENT

A. Sump Level Monitor

1. The monitor shall be of the float switch type. The instrument shall have a pipe size threaded nipple.

2. The float and stem material shall be polypropylene.

3. The enclosure shall be watertight. The switch shall support minimum 120VAC and shall be normally open and close upon float actuation.

4. Float switches GEMS LS-3 series or equal.

B. Submersible Level Sensor for stilling well use

1. Sensor shall be submersible type, 316L SS, with a stainless steel diaphragm and a ceramic measuring cell that is resistant to overload, alternating loads, and aggressive media

2. The sensor shall be designed for level measurement of water or wastewater

3. The sensor shall be a two-wire device that provides a 4-20mADC output.

4. The sensor shall be loop-powered from 12-30VDC.

5. All electronics shall be completely potted with compound to protect from moisture damage.

6. The support cable shall have a hard-wearing conical seal of the probe tube and climactic protection in the pressure compensation tube.

7. The unit shall have a range as indicated on the Contract drawings.

8. The sensor accuracy shall be 0.5% of full scale, minimum.

9. A mounting clamp and NEMA 4X junction box shall be furnished with the sensor for field installation. The cable shall be of a length sufficient to meet the requirements of the Contract drawings.

10. The sensor range shall be as indicated on the Contract drawings

11. The sensor shall be Endress-Hauser Water-Pilot, or equal.

C. Differential Pressure Cell & Transmitter

1. The transmitter shall be Foxboro Model IDP10, or equal, for measuring differential pressure.
2. The transmitter shall loop-powered
3. The transmitter shall transmit a 4-20 mA signal when supplied with voltage in a range from 11.5 to 42 VDC
4. The transmitter shall have an LCD display with on-board pushbuttons
5. The transmitter shall have an external zero adjustment
6. The transmitter shall be configurable to cutoff to zero at flows <10% of maximum flow
7. The transmitter shall have a Type 316 stainless steel cover and housing. It shall be rated NEMA 4X.
8. The transmitter range shall be as indicated on the Contract drawings. Where used as a flow transmitter, pressure cell is required to have a direct reading in GPM.
9. The transmitter shall be equipped with a three-valve manifold, stainless steel
10. The transmitter shall be FM approved for use in Class 1 Division 1 Group A, B, C, and D locations.
11. Accuracy shall be +/-0.2 percent of calibrated span, minimum. Repeatability shall be better than 0.5 percent of calibrated span.
12. The transmitter shall be equipped with HART communications.
13. The transmitter shall be furnished with a stainless steel mounting bracket.
14. Manufacturer warranty shall be 5 years, minimum.

D. Level Transmitter (Pressure Cell type)

1. The transmitter shall be Foxboro Model IGP20, or equal, for measuring gauge pressure. It shall have units of either Feet or %.
2. The transmitter shall loop-powered
3. The transmitter shall transmit a 4-20 mA signal when supplied with voltage in a range from 11.5 to 42 VDC
4. The transmitter shall have an LCD display with on-board pushbuttons
5. The transmitter shall have an external zero adjustment
6. The transmitter shall have a Type 316 stainless steel cover and housing. It shall be rated NEMA 4X.
7. The transmitter range shall be as indicated on the Contract drawings.
8. The transmitter shall be equipped with a capillary and diaphragm seal appropriate for the chemical involved where indicated on the Drawings. Otherwise provide a 3-valve stainless manifold with bleed ports.
9. Accuracy shall be +/-0.075 percent of calibrated span, minimum. Repeatability shall be better than 0.5 percent of calibrated span.
10. The transmitter shall be equipped with HART communications.
11. Mounting bracket, if used, shall be stainless steel.
12. Manufacturer warranty shall be 5 years, minimum.

E. Turbidimeter System, Low Range

1. The Turbidimeter system shall be a Hach Tu5300 or equal with SC200 controller, or equal, to continuously indicate and transmit low range turbidity based upon nephelometric measurement.
2. The system shall be suitable for regulatory reporting, and shall comply with USEPA 180.1 criteria.
3. The turbidimeter shall be suitable for continuous sample flow, and shall not be affected by flow or pressure variations.
4. The controller shall support datalogging, alarm history, and plug-and-play swap-out of turbidimeter.
5. Accuracy shall be +/- 2% of reading or +/-0.015 NTU(whichever is greater), minimum.
6. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU, and shall be scaled as indicated on the Contract drawings.
7. The turbidimeter body shall be constructed of corrosion-resistant polystyrene.
8. Calibration of the instrument shall be either formazin-based or instrument comparison-based calibration method. All necessary materials and equipment for calibration shall be provided.
9. The turbidimeter shall have a 4-20mA analog output, and at least one alarm contact output.
10. Controller shall be NEMA 4X enclosed, suitable for 120VAC power supply.
11. Manufacturer warranty shall be 2 years, minimum.

F. Chlorine Analyzer

1. The chlorine analyzer shall be Hach Model CL17, or equal.
2. The chlorine analyzer shall employ a DPD colorimetric method of measurement using DPD indicator and a buffer solution.
3. The analyzer shall be capable of measuring free or total residual chlorine as indicated on the Contract drawings. It shall be capable of switching between free or total chlorine measurement by changing the indicator and buffer solutions.
4. A measurement shall be taken every 2.5 minutes and results displayed by a three digit LCD readout in the range of 0-5 mg/L
5. The analyzer shall be designed for 30-days unattended operation and use only 473 mL of each reagent per month.
6. The analyzer shall provide a minimum detection limit of 0.035 mg/L or better, precision better than +/- 5% or 0.005 mg/L of Cl_2, and accuracy better than +/-5% or 0.035 mg/L of Cl_2.
7. The analyzer shall provide a 4-20mA recorder output and 2 relay alarms. The alarms shall be user-selectable for sample concentration alarms (high or low and fully adjustable through the entire range), analyzer system warnings, or analyzer system shutdown alarms.
8. The analyzer shall be housed in an IP-62 rated, ABS plastic enclosure designed for wall mounting. The enclosure shall have two clear polycarbonate windows for viewing the measurement readout and reagent levels.

9. The analyzer shall operate from voltage of 115 VAC +/-10%, 60Hz.

G. Flow Switch - Water
   1. The flow switch shall have a repetitive accuracy of +/- 5% of actual flow setting.
   2. Switch actuation shall be adjustable over the operating flow range.
   3. Flow switch shall be rated for use and constructed of suitable materials for installation in the environment encountered.
   4. The flow switch shall have Form C contacts.
   5. The flow switch range shall be as dictated by the equipment manufacturer.

H. Venturi Flowtube (Filter flow meters only)
   1. The flowtube shall be Primary Flow Signal, Inc. Model HVT-CI, or equal.
   2. The flowtube shall operate on the differential pressure principle.
   3. The flowtube shall be constructed of ASTM A126, Grade B Cast Iron, with SS304 throat and piezometer tap sleeves.
   4. Accuracy shall be +/-0.5% of actual reading, or better.
   5. The flowtube shall have a pressure capacity of 150 psig
   6. The flowtube shall be furnished with a calibration certificate and flow vs. differential curves.
   7. Provide an indicating differential pressure flow transmitter.
   8. Flowtube range and size shall be as indicated on the Contract drawings
   9. Manufacturer warranty shall be 10 years, minimum.

I. Electromagnetic Flowmeter and Transmitter (Water/Wastewater)
   1. The electromagnetic flow meter shall consist of a flow sensor based on Faraday's Law of Electromagnetic Induction and microprocessor-based signal converter & transmitter.
   2. The sensor flow tube liner material shall be EPDM rubber for drinking water applications. Measurement and grounding electrodes shall be 316 stainless steel. Flow tube shall have corrosion resistant epoxy coating. Drinking water flow meters shall be approved by NSF.
   3. In wastewater applications or where indicated on the Drawings, the flowtube assembly shall be FM approved for a Class 1 Division 2 area, and shall be rated NEMA 6P with 3 foot submersion capability for up to 30 minutes.
   4. Operating temp: Operating Temp: -5 to +120° F minimum acceptable band
   5. Display: Background illumination with alphanumeric 3-line, 20-character display to indicate flow rate, totalized values, settings, and faults
   6. Power supply: 115/230 VAC or 24VDC as indicated on Contract Drawings.
   7. Outputs: 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1A. Provide Digital pulse for external display of flow rate or totalizer.
   8. Flow Range: 1.5 fps to 33 fps for accuracies stated below.
   9. Accuracy: 0.5% of actual flow.
   10. Separation: Allowable distance of 900 feet between signal converter and sensor without the use of any additional equipment
   11. Provide Bi-directional flow capabilities
   12. Totalizer: Two eight-digit counters for forward, net, or reverse flow.

13. The transmitter shall be mounted integrally or remotely as indicated on the Drawings.
14. Insertion type flow meters will not be accepted.

J. Weight Scale and Transmitter
    1. The drum scale platform shall have a 2-part epoxy finish and shall be sized to accept a tank of the diameter indicated on the Contract drawings and in the equipment specifications. Four adjustable hold-down lugs shall be provided on the platform to increase lateral stability and to allow the use of hold-down straps for securing the vessel to the platform. Scale shall be of the single-load cell design. Weight shall be transferred via a pivoted platform to a single NTEP approved load cell of the shear beam strain gauge type. Flexible cable shall connect load cell to indicator to allow easy remote installation of the readout. Drum Scale shall be Force Flow Equipment Chem-Scale, or equal.
    2. Transmitter shall be housed in a NEMA 4X, UL-approved enclosure. It shall independently monitor up to 4 scales. Digital display shall be a 2 line, 16 character, backlit alphanumeric LCD type. It shall be equipped with a numeric keypad for easy input of tare and level alarm values.
    3. Operator shall be able to monitor chemical by weight, volume, or percent full. An auto-load function shall automatically compensate for tank tare weight during tank change. Each channel shall have a user-selectable, two-digit scale ID number and shall display Net Remaining, Feed Rate, Daily Usage, Total Amount Used, Days Until Empty, Gross Weight, and Tare Weight. A data log function shall store the daily usage for each of the previous 10 days.
    4. Each scale shall have an independent adjustable 4-20mA output signal configurable for net weight or feedrate.
    5. The Transmitter shall have up to 4 low-level alarm relays with adjustable setpoints.
    6. The primary cable shall be provided in a length sufficient to meet the requirements as indicated on the Contract drawings.
    7. Full-scale accuracy shall be 0.25%, minimum.
    8. Transmitter shall have RS-485 Modbus communications.
    9. The transmitter shall be the Force Flow Equipment Wizard 4000, or equal.

K. Instrument Valves (1/4” through ¾”)
    1. Shutoff valves shall be provided on each pressure line to an instrument and accessory item, and shall be bronze ¼ turn ball valves with Teflon seats as manufactured by Whitey Co., Gould, Hoke, Apollo, or equal. Valves shall have a corrosion resistant handle.
    2. Throttling valves where required and/or shown on the Contract Drawings shall be bronze globe valves, NUPRO “J” Series, Hoke 3700-3800 Series, or equal. Valves shall have a corrosion resistant handle.

L. Tubing

1. Tubing for pressure lines to transmitters shall be hard drawn copper or 316 stainless steel. Bulkhead fittings, bushings, etc., shall be those especially designed for the tubing and used at all terminations. Tubing shall be Type “L” copper bent with bending tools, o as to have a minimum number of joints. Solder joint fittings are not allowed; compression type shall be utilized, Swagelok or equal.
2. All runs of tubing shall be straight, parallel to walls with a slope to a drip leg at each connection to a transmitter, where the transmitter is below the primary element. Horizontal liquid-filled lines shall slope at least 1 inch per foot downward toward the measuring element to ensure that air or gas bubbles return to the main flow line or tank.

2.03 SURGE PROTECTION FOR INSTRUMENTATION

A. Local Surge Protection Device for Analog 4-20mA loops.

1. The local surge protection device shall be installed at the location of the instrument it is protecting.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 10 ohms.

3. The device shall be Class 1, Div. 2 certified under UL1604 if it is located in a hazardous area as indicated on the Contract drawings.

4. The device shall be housed in a stainless steel pipe stub or similar for installation on a field-mounted conduit body. Temperature range shall be –40°C to 80°C.

5. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 270mA continuous current.

6. The device shall be a Phoenix Contact “Pipetrab” surge protection device, or equal.

2.04 MISCELLANEOUS ACCESSORIES

A. Flange Adapters – Dresser Style 128 or equal for steel, ductile iron, or cast iron piping. Contractor must ensure the proper type of flange is procured. Provide restraints where specified in Division 2.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. General

1. All piping to and from field instrumentation shall be provided with necessary unions, tees, adapters, and shut-off valves.

2. Install all equipment in accordance with the manufacturer's installation and maintenance information.

3. Provide and install all necessary mounting equipment, brackets, required for mounting of equipment.

4. Instrument cables shall be pulled without undo stress that may aggravate the number of twists per foot. Shields shall be continuous and shall be only grounded at one end.

5. Place duct seal around the wires in each conduit entering every instrument enclosure for the project.

6. All instruments and equipment shall be left free from shipping burrs, paint overspray, grease, etc. All scratches shall be touched up with manufacturer's matching paint.

7. Provide a local surge protection device at all instruments mounted outside.

8. Install on each instrument, transmitter, recorder, indicator, etc., a plastic engraved white with black letters nameplate secured to the panel. Nameplates shall be permanently secured with stainless steel screws if it does not interfere with the NEMA rating of the box. Instruments shall be supplied with a stainless or aluminum engraved tag with black letters if no flat spot exists for a nameplate. Chain shall be stainless steel.

9. Locate instruments as shown on the electrical drawings and primary elements as shown on the electrical or plant process drawings.

10. Transmitters or indicators shall not be mounted from process piping or hangers, only the building structure.

11. Remove all shipping tags, lifting rings, from enclosures. Plug all non-used holds in enclosures.

12. The system supplier shall coordinate the installation through the Contractor.

13. The placing and location of system components, their connections to the process equipment panels, cabinets and devices, shall be coordinated with the Engineer's acceptance.

14. Magmeters shall be installed with flange adapters to facilitate installation and removal.

3.02 STARTUP SERVICES

A. After equipment and materials have been shipped to the job site, the Contractor shall furnish the services of a factory-trained service technician or engineer to assist and advise the Contractor during installation and to provide calibration/adjustment at initial startup.

B. Following installation, checkout, and final adjustment of all panels, instruments, meters, monitoring, and control devices, the Contractor shall schedule a performance test in the presence of the Engineer on all equipment. The Contractor shall furnish the services of servicemen, all special tools, calibration equipment, and labor to perform the tests.

C. Meters shall be tested at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of scale, if possible. All status and alarm switches as well as all monitoring and control functions shall also be checked. Testing shall be done from the signal source to the final element or device including all field wiring.

D. If, during running of the tests, one or more points appear to be out by more than the system accuracy statement, the Contractor shall make such adjustments or alterations as are necessary to bring equipment up to specification performance. Following such adjustment, the tests shall be repeated for all specified points to ensure compliance.

END OF SECTION

SECTION 17200

SCADA HARDWARE

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install all materials, services, spare parts, start-up services, as shown and specified and as required to install a complete and functional supervisory control and data acquisition (SCADA) system as indicated on the Drawings and as described herein.

B. Provide power line, I/O point, and fieldbus/dataline surge protection as indicated and as specified herein.

C. Provide SCADA hardware training services as specified herein.

D. Additional requirements are specified in Section 17010.

1.02 RELATED WORK

A. Installation of all electrical equipment, conductors, and related items shall be in accordance with all applicable sections of Division 16 of these specifications.

B. General Requirements are included in Division 1.

C. Division 11 – Equipment

D. Section 16900 – Control Panels

E. Section 17010 - General Instrumentation and SCADA requirements.

F. Section 17400 – SCADA Software

1.03 SUBMITTALS

A. Shop drawing approval is required before the Contractor purchases or installs any equipment. Submit in accordance with Section 17010.

B. Operation and Maintenance Manuals shall be submitted in accordance with Section 17010.

1.04 QUALITY ASSURANCE

A. See Section 17010 for requirements.

1.05 WARRANTY AND SERVICE

A. See Section 17010 for requirements.

1.06 SPARE PARTS

A. Furnish one spare I/O Module for each unique I/O module type installed.

B. Furnish one spare communication module for each unique communication module installed.

C. Furnish one spare power supply for each unique power supply installed.

D. Ten fuses of each size/type in the system.

E. Five spare pilot lights of each type used in the system.

1.07 TRAINING

A. Training shall be in accordance with Section 17010.

B. The on-site SCADA hardware training shall be a minimum of one 8 hour day on-site.

1.08 TERMINOLOGY

A. CCC – Central Control Cabinet: Includes main programmable controller, inputs, outputs, and other required equipment.

B. DCC – Distributed Control Cabinet: Includes compact programmable controller, inputs, outputs, and other required equipment. The compact controller can communicate with the main controller and other compact controllers via the plant network.

C. IOC – Input-Output Cabinet: Includes inputs and outputs which are addressed and controlled from the main programmable controller.

D. MTU – Master Telemetry Unit: A radio with associated equipment used to communicate to remote locations.

E. RTU – Remote Telemetry Unit: A radio with inputs and outputs used to communicate with the master telemetry unit or other remote telemetry units.

F. PLC – Programmable logic controller

PART 2 – PRODUCTS

2.01 GENERAL

A. Acceptable manufacturers of SCADA hardware shall be Allen-Bradley, General Electric, or Schneider/Modicon. Manufacturers of small peripheral equipment are listed with each piece of equipment.

B. All equipment must be able to reset after a power outage without having to be manually reset.

C. All equipment mounted outdoors shall be protected from the sunlight, and extreme temperatures between –20 degrees and 140 degrees Fahrenheit. Provide all necessary shielding, heaters, or air conditioners as required. All externally mounted panels shall have self-sacrificing corrosion inhibitors installed.

2.02 SCADA CABINETS

A. General: All control cabinets shall be provided compliant with Section 16900 and with the following features:

1. Enclosure: Sized for 10% spare panel space with a single 3-point roller latch. Screw clamps are unacceptable. NEMA rating shall be as indicated on the plans (NEMA 12 minimum). Aluminum cabinets shall not be used in uncontrolled temperature environments due to thermal expansion issues. Components installed in the exterior of the enclosure shall maintain the NEMA rating of the enclosure. All enclosures shall have a padlock hasp.

2. Rotary IEC style lockable main disconnect with main circuit breaker and transient voltage surge suppression with alarm contact.

3. Uninterruptible power supply (UPS) with alarm contact. A power relay shall be provided and wired such that, if the UPS fails the relay shall drop out and the panel shall be powered from utility power.

4. Provide 24VDC power supply, miscellaneous breakers, fuses, terminal blocks, wiring duct, and other panel components

6. Fiber optic media converters as required

7. Control power push-to-test pilot light and interior GFCI protected duplex receptacle

8. Magnetic contact switch or limit switch to alarm when cabinet is opened.

9. Provide prewired with all field wiring landed on terminal blocks for field installation

10. Circulation fan to prevent hot-spots inside the cabinet. This fan can be combined with the enclosure heater (Hoffman panel heater) as long as the fan runs continuously.

11. For cabinets at remote locations, including pump stations and water tanks, all components shall be mounted on an interior dead-front swing-out panel. No indicators or pilot lights shall be visible from the exterior without opening the outer enclosure door.

B. Central Control Cabinet (CCC)- Provide with the following features:

1. Compact programmable controller, modular and chassis based with all required inputs and outputs and communications modules as required to meet the requirements of the Contract drawings and these specifications. Chassis shall be sized for 25% spare I/O slots.

C. Input/Output Cabinet (IOC) – Provide with the following features:

1. Communications adapter and remote inputs and outputs as required to meet the requirements of the Contract drawings and these specifications. Provide 25% spare I/O, and arranged for future I/O expansion.

2.03 CONTROLLERS AND I/O

A. Compact Programmable Controller and chassis-based I/O
1. The compact programmable controller shall be Allen-Bradley CompactLogix, or equal.
2. The compact programmable controller shall include a chassis, power supply, processor, I/O modules, communications modules, cables, and all other components required to make a complete, functional system.
3. The compact programmable controller shall be programmable with the same software program as the main programmable controller
4. Processor Unit:
    a. Provide 1769-L33ER or equal.
    b. Processor Memory: 2 megabytes, battery backed RAM, minimum
    c. Capability of controlling up to (16) local I/O modules
    d. Shall have typical throughput Time of 0.08 ms/K based upon a 1K ladder logic program consisting of simple ladder logic and communications servicing.
    e. Shall have Bit Execution Time of less than 0.51 microseconds
    f. Shall support Proportional Integral Derivative Control with up to 451 microsecond execution time
    g. Shall support online programming including runtime editing
    h. Memory Back-up provided through minimum two year lithium battery
    i. LED indicators including: POWER, RUN, Fault, Network status
    j. One USB port
    k. Shall support a Real Time Clock

l. The processor shall support Ethernet communications via RJ-45 connection
m. Provide a SD card for non-volatile program storage.

5. Discrete Input Modules
    a. Provide 16 inputs, minimum.
    b. Shall include removable terminal block
    c. Shall include LEDs to indicate the status of each I/O point
    d. Shall include optical isolation between digital and field circuits
6. Discrete Output Modules
    a. Shall be either a relay output module with minimum (8) individually isolated outputs, or a transistor output type with minimum (16) outputs and interposing relays provided.
    b. Shall include removable terminal block
    c. Shall include LEDs to indicate the status of each I/O point
    d. Shall include optical isolation between digital and field circuits
7. Analog Input Modules
    a. Provide minimum (4) isolated input channels per module
    b. Current Rating of 0 to 20mA, 4 to 20mA
    c. Minimum resolution of 14 bits
    d. Input Group to Bus Isolation of 500Vac for (1) minute
    e. Removable terminal block
    f. LEDs to indicate the status of each I/O point
8. Analog Output Modules
    a. Provide minimum (4) isolated output channels per module
    b. Current Rating of 0 to 20mA, 4 to 20mA
    c. Shall drive a resistive load of minimum 500 ohms.
    d. Resolution of 14 bits minimum
    e. Open and short-circuit protection
    f. Output voltage protection
    g. Input Group to Bus Isolation of 500V ac for (1) minute
    h. Removable terminal block
    i. LEDs to indicate the status of each I/O point
9. Remote I/O: Remote I/O shall be CompactLogix Type 1769 I/O as specified above with a 1769-AENTR Ethernet/IP adapter module.

2.04 CONTROLLER AND I/O SOFTWARE

A. Development version of Studio 5000 software is NOT required on this project.

2.05 COMPUTERS

A. SCADA Workstation: Provide the following features
1. Provide HP, or equal
2. Processor: 3.6 GHz Quadcore i7 processor, 8 MB cache minimum
3. 16 GB memory, minimum
4. Windows Server 2016 operating system
5. USB Keyboard and USB Optical mouse
6. Read & Write DVD/RW (16X) and CD/RW (48X) Drive

7. 500 GB Harddrive solid-state
8. 16 gigabyte USB memory key
9. Two (2)10/100/1000 Ethernet NIC cards
10. 24” (minimum) Flat Panel Monitor, 16:9 aspect ratio
11. Basic speakers
12. Microsoft Office 2019 with Word and Excel
13. Uninterruptible power supply, 420VA minimum

B. Backup (Redundant) Workstation: shall be exactly equal to the primary SCADA Workstation.

2.06 SURGE SUPPRESSION

A. Cabinet Power Supply Surge Protective Device (SPD)

1. The power supply SPD shall be a Din-Rail-Mounted device and shall be installed to protect the equipment in the cabinet from harmful surges and voltage spikes.

2. The SPD shall have nominal ratings of 120VAC and 26A minimum. Temperature range shall be –40°C to 80°C.

3. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 500V. The response time shall be less than or equal to 25 nanoseconds.

4. The device shall be a Phoenix Contact “Mains-Plugtrab PT Series,” or equal.

B. Digital 24VDC I/O SPD

1. The SPD shall be DIN-rail-mountable and shall be installed to protect the digital 24VDC SCADA I/O. Temperature range shall be –40°C to 80°C.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 42VDC. The response time shall be less than or equal to 25 nanoseconds. The resistance of the device shall be no more than 4.7 ohms.

4. The device shall be suitable for use on 24VDC circuit with up to 300mA continuous current.

5. The device shall be a Phoenix Contact “MCR-Plugtrab PT” surge protection device, or equal.

C. Digital 120VAC I/O SPD

1. The SPD shall be DIN-rail-mountable and shall be installed to protect the digital 120VAC SCADA I/O. Temperature range shall be –40°C to 80°C.

2. The device shall have a surge handling capacity of 10kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 600V. The response time shall be less than or equal to 25 nanoseconds.

4. The device shall be suitable for use on a 120VAC circuit with up to 26A continuous current.

5. The device shall be a Phoenix Contact “MCR-Plugtrab PT” surge protection device, or equal.

D. Analog I/O SPD

1. The Din-Rail-Mounted surge protection device shall be installed to protect the analog SCADA I/O.

2. The device shall have a surge handling capacity of 20kA (8/20microsecond) minimum. It shall have hybrid technology for “fine” voltage clamping and “coarse” surge current handling. The clamping voltage shall be less than or equal to 40V (Conductor to conductor) and 450V (conductor to ground). The response time shall be less than or equal to 1 nanosecond (conductor to conductor) or 100 nanoseconds (conductor to ground). The resistance of the device shall be no more than 2.2 ohms.

3. The device shall be suitable for din-rail mounting, and shall be no more than 17.5 mm thick. Temperature range shall be –40°C to 80°C.

4. The device shall be suitable for use on a 4-20mA analog circuit with 28VDC continuous operating voltage and up to 450mA continuous current.

5. The device shall be a Phoenix Contact “MCR-Plugtrab PT” surge protection device, or equal.

2.07 MISCELLANEOUS EQUIPMENT

A. Din Rail Mount Uninterruptible Power Supply (UPS) – For use inside enclosures.
1. The UPS shall be manufactured by Allen-Bradley, or equal.
2. The UPS shall be designed for Din rail mounting inside industrial control panel enclosures. It shall have screw terminations for all wiring points.
3. The UPS shall operate off of 120V +/-10% with a capacity of 500VA.
4. The UPS shall be UL 1778 recognized.
5. The UPS shall have a dry contact to indicate alarms.

6. The UPS shall have integral overload protection.
7. Simulated sine wave is required. Square wave output is not acceptable.
8. Operating temp shall be 0-50 degrees C.
9. The UPS shall handle normal shock and vibration of industrial use without damage.

B. Uninterruptible Power Supply (UPS) – For use with separate computers only.
1. The UPS shall be an American Power Conversions (APC), Liebert, or equal.
2. The supply voltage shall be capable of 120VAC +/- 23%.
3. The UPS shall be capable of operating properly within a frequency range of 60 Hz +/- 3%.
4. Operating Ambient Temperature Range: 32 to 104 F minimum.
5. The UPS shall have an output rating of at least 150% of the load to be served, but shall not be less than 420VA. It shall be sized for 30-minute minimum backup power.
6. The UPS shall provide 120VAC output voltage with voltage regulation within +/- 4% for both normal and battery operation.
7. The UPS shall be equipped with circuitry to protect itself from overloads and short-circuits.
8. The UPS shall be able to withstand 110% overload for at least five (5) minutes.
9. The UPS shall have a maximum transient recovery time of 30 milliseconds.
10. The UPS shall maintain a battery recharge rate designed to prolong battery life. The battery charger shall maintain a constant voltage and current charge and maintain the battery in a fully charged state. Recharge time shall be three (3) hours maximum to 95% capacity after discharge into a full load.

C. Loop Isolator and Signal Converters: The loop isolator or signal converter shall be provided where indicated or specified, to isolate signals or to increase the load capacity of a system required to have many devices in the loop. Isolators shall provide 3-way isolation and shall have a power supply voltage of 120VAC unless otherwise indicated. Isolators and converters shall be Action Instruments, Phoenix Contact, or equal, and enclosed as appropriated for the application or as indicated.

D. Modbus TCP Gateway – Provide Moxa MB3180 or equal.

2.08 DATA HIGHWAYS AND ASSOCIATED EQUIPMENT

A. Link the system and associated equipment into an integrated ethernet network as indicated in the SCADA architecture diagram.

B. Plant-wide Network

1. Programmable controllers and distributed I/O blocks shall include an Ethernet Adapter port. The selected messaging protocol for this port shall be TCP/IP and shall provide high throughput with error detection and correction.

2. The network shall operate at a speed of 10M bits per second or faster.

C. Provide cables as required to interconnect each network component. Provide all cables and connectors for programmable products. Cables shall be installed in conduit and/or underground duct under Division 16.

1. New cabling shall be equal to Belden Category 5e UTP, or equal.

2. New cabling underground, or as shown on the Contract Drawings shall be fiber optic as specified in Section 16710.

D. Fiber Optic Media Converter

1. Fiber Optic Media Converter - The media converter shall convert Ethernet signals to fiber optic, and shall convert fiber optic signals to Ethernet. Media converters shall be used at each fiber termination as indicated on the Contract Drawings. Media Converters shall be Phoenix Contact or equal. Provide 24VDC power supply where necessary.

PART 3 EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Install all equipment in accordance with the manufacturer's installation and maintenance information.

B. Provide and install all necessary mounting equipment, brackets, required for mounting of equipment.

C. Data highway cables shall be pulled without undo stress that may aggravate the number of twists per foot.

D. Place duct seal around the wires in each conduit entering every SCADA cabinet for the project.

E. All equipment shall be left free from shipping burrs, paint overspray, grease, etc. All scratches shall be touched up with manufacturer's matching paint.

F. Provide SPDs on the power supply circuit to each SCADA cabinet. Provide SPDs on each analog and digital termination where the wires extend outside the perimeter of the building.

G. Locate equipment as shown on the electrical drawings.

H. Remove all shipping tags, lifting rings, etc. from enclosures. Plug all non-used holes in enclosures.

I. The placing and location of system components, their connections to the process equipment panels, cabinets and devices, shall be coordinated with the Engineer's acceptance.

3.02 STARTUP SERVICES

A. Following installation, checkout, and final adjustment of all hardware, the Contractor shall schedule a performance test in the presence of the Engineer on all equipment. This test shall be concurrent with the SCADA software test.

END OF SECTION

SECTION 17350

FILTER CONTROL SYSTEM

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. Work Included: The equipment described in this section is required to be furnished by the filter supplier. Refer to Division 11 for the filter specifications. This section requires the furnishing and installation of filter control systems and instrumentation as shown on the Contract drawings and as specified herein.

B. References

1. NSF - Standard 61 - Drinking Water Systems Components - Health Effects.

1.02 RELATED WORK

A. Installation of all electrical equipment, conductors, and related items shall be in accordance with all applicable sections of Division 16 of these specifications.

B. Division 11 – Equipment

C. Section 16900 – Control Panels

1.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Requirements: A complete filter control system shall be provided for controlling and monitoring the operation of the filter system. The control system shall include all instrumentation, equipment, and programming required for a complete and operational filter control system.

1.04 QUALITY ASSURANCE

A. Manufacturer: F. B. Leopold Company or equal

B. NSF Certification: All materials used in contact with the water shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects

C. The Contractor shall coordinate all work performed by the filter supplier to ensure a complete and operable filter control system.

D. Each filter console shall be UL508 listed and shall comply with Section 16900 unless noted otherwise herein.

1.05 SUBMITTALS

The supplier shall submit to the engineer complete shop drawings showing all control panel layouts, schematics, bills of material, wiring diagrams, instrumentation and equipment data sheets, applicable calculations, and description of operation.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Complete operation and maintenance instructions shall be included.
B. Manuals shall include all the info included in the shop drawing submittal, with updates for complete record drawings indicating final installation, interconnections among field mounted equipment, and as-built wiring.
C. Include complete addresses of all equipment manufacturing representatives and phone numbers of each.
D. Include complete manufacturer's installation, operations, and maintenance manual for each piece of equipment and software supplied.
E. Complete parts lists with stock numbers.
F. Include a configuration record for each piece of equipment, including all parameter settings and set points.
G. Record of all as-built parameters programmed into loop controllers and instruments.
H. Manufacturers' standard instruction bulletins for all functional components.

1.07 SPARE PARTS

A. Furnish one spare loop controller for each unique loop controller installed.
B. Furnish one spare instrument for each unique instrument installed.
C. Furnish one spare power supply for each unique power supply installed.
D. Ten fuses of each size/type in the system.
E. Five pilot light LEDs of each type used in the system.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A complete filter control system shall be provided. The control system shall include all equipment and instrumentation required for a complete and operational filter system.

As a minimum, the control system shall consist of the following:

A. One filter control console for each filter
B. Other instrumentation as indicated on the Contract Drawings and specified herein
C. Other instrumentation as required for a complete, operational filter system

2.02 FILTER CONTROL CONSOLE

A. A Filter Control Console shall be provided for controlling and monitoring the operation of each filter.
B. Each console shall be provided complete with the necessary control devices, equipment, and functional programming to perform the control and monitoring functions specified. The consoles shall match the Owner's existing filter consoles as closely as possible.
C. Functional Description
    1. Each console shall have the capability of manually controlling the filtration and backwash sequence for a single filter.
    2. An electronic valve positioner/controller shall be provided for the effluent and backwash control valves. The valve positioner/controller shall include AUTO/MANUAL and an INCREASE/DECREASE buttons. In AUTO mode, the unit shall accept a remote setpoint signal and position the flow control valve to maintain the flow setpoint. The unit shall support ON/OFF, Proportional (P), Proportional with Integral and/or Derivative (PI, PD, PID). In MANUAL mode, the flow will be adjusted manually by pressing the appropriate INCREASE/DECREASE button. The unit shall have a dual LED display for indicating the flow setpoint and the actual flow in GPM.
    3. The console shall have OPEN/HOLD/CLOSE selector switches for manual control of the effluent and backwash control. The console shall have OPEN/CLOSE selector switches for manual control of the influent, waste, rewash, and surface wash valves.
    4. The console shall include digital loop displays for filter turbidity and loss of head.
    5. The console shall provide dry-contact open and dry-contact close outputs for each valve controlled from the console. It shall accept dry-contact limit switch inputs from each valve and shall have pilot lights for indication of fully-opened and fully-closed position.
    6. Provide controls for starting (2) backwash pumps. Backwash pump #1 shall include start and stop pushbuttons and a "running" pilot light. Backwash pump #2 shall include an "off-on" two-position selector switch and "running" pilot light.
    7. Components:
        a. The enclosure shall be a totally enclosed, sloped top console. It shall be manufactured of fiberglass reinforced plastic (FRP) or fiberglass having a minimum wall thickness of 1/8 inch (3.2 mm).
        b. The loop controllers shall be Honeywell and match the Owner's

existing loop controllers as close as possible

c. The loop displays shall be Precision Digital and match the Owner's existing loop displays as close as possible.
d. Miscellaneous circuit breakers, pushbuttons, selector switches, pilot lights, relays, terminal blocks and other controls shall be as specified in Division 16.

8. Wiring
   a. The console shall be completely pre-wired except for wires to external devices, which shall be brought to lugless tubular screw with pressure plate terminal blocks. All wiring shall be in compliance with the National Electric Code (NEC) and shall be listed UL508.
   b. Minimum wire size for 120 VAC power wiring shall be #16 AWG stranded copper conductor, 600V, 90 degrees C with thermoplastic insulation. Minimum wire size for 24 VDC power wiring shall be #18 AWG stranded copper conductor, with thermoplastic insulation. Minimum wire size for DC signal wiring shall be #18 AWG twisted, shielded pair with drain wire (Belden 8760 or equal), grounded in accordance with ISA Recommended Practice for signal wiring
   c. Wires shall be color coded as follows:

120 VAC, 2 wire, single phase:
Phase - L1, Black
Neutral-L2, White
Externally powered circuit - Yellow
120 VAC control - Red
24 VDC Control - Blue
Ground - Green, or green with yellow stripes.

D. Interface to SCADA system: Provide the following outputs to SCADA:
   1. Turbidity: provide isolated 4-20mA signal
   2. Loss of Head: provide isolated 4-20mA signal
   3. Effluent Flow Rate: provide isolated 4-20mA signal
   4. Backwash Flow rate: provide isolated 4-20mA signal
   5. Alarms: provide dry contacts

2.03 INSTRUMENTATION

A. Venturi Flow Meters: See Section 17100
B. Flow Transmitters: See Section 17100
C. Filter Loss of Head Transmitters: See Section 17100
D. Effluent Turbidimeters: See Section 17100

PART 3 - EXECUTION

3.01 FILTER CONTROL INSTALLATION AND START-UP SERVICE

1. The Contractor shall be responsible for installation of the filter control consoles and all wiring from the console to field devices, instruments, and other systems.

2. The Contractor shall provide the services of the filter system manufacturer for startup/commissioning. The factory service technician shall have a minimum of five years experience in the start-up of water filter backwash systems.

3. Start-up shall be performed with all final elements, field devices, instruments installed, calibrated and wired in the circuit.

4. The Contractor shall ensure that all of the relevant personnel are available and onsite for coordination of the filter startup.

3.02 TECHNICAL DIRECTION

1. Install all items in accordance with the instruction of the filter equipment manufacturer, under the direct technical supervision of the manufacturer. The filter equipment manufacturer's technical director shall supervise the installation of all filter control systems.

2. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filter control system has been installed in accordance with the manufacturer's instructions.

3.03 TRAINING

A minimum of one 8-hour day of on-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day-to-day operations of the controls, preventative and regular maintenance, trouble-shooting techniques, and system diagnostics.

END OF SECTION

SECTION 17400

SCADA SOFTWARE

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide SCADA software, software development, testing, commissioning, debugging, and maintenance services as specified herein. Provide all materials, labor, software, and services as required to implement a complete and functional system.

B. Integrate each I/O point indicated on the Contract drawings into the SCADA software.

C. Provide software operation training services.

1.02 RELATED WORK

A. General requirements are located in Division 1.

B. Section 17010 – General Instrumentation/SCADA Requirements

C. Section 17200 – SCADA Hardware

1.03 SUBMITTALS

A. Software submittals shall be submitted in accordance with Section 17010.

B. Operation & Maintenance manuals shall be submitted in accordance with Section 17010.

1.04 QUALITY ASSURANCE

A. See Section 17010 for requirements.

1.05 WARRANTY & SERVICE

A. See Section 17010 for requirements.

1.06 TRAINING

A. Software training shall comply with Section 17010 requirements.

B. Onsite Software Training: Onsite software training shall be conducted by the Contractor and shall consist of a minimum of one eight-hour day.

1.07 GENERAL SCADA SOFTWARE REQUIREMENTS

A. The SCADA software shall consist of a human machine interface (HMI) system with support for supervisory and process control, real-time data acquisition, alarm and event management, historical data collection, report generation, local or remote telemetry communications to PLC's/RTU's and internet/intranet access. The software shall be easy-to-use, with an object-oriented graphics development environment and shall have an open architecture, which utilizes the latest in Microsoft Windows technology from Microsoft. The system shall have the built-in flexibility to permit easy configuration of the system in accordance with the specific end user requirements as well as quick and easy modification by the end user in the field. The software shall consist of a suite of off-the-shelf modular components from a single software manufacturer that are tightly integrated together to perform all SCADA system functions. The suite shall contain an HMI for process visualization, a Real-Time relational database for historical data collection, client tools for trending and reporting within the HMI and as standalone, and communication drivers for PLC/RTU's. It shall be scalable so that a small, single, stand alone application can easily be expanded into a large distributed control network with either single or redundant database servers, single or redundant communication servers providing information to multiple workstation clients.

B. The software shall be furnished with licensing for enough tags to cover all of the I/O on the Contract drawings with at least 30% spare tags. Contractor shall print out the tag count during performance testing and verify that 30% spare tags are available.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Approved software manufacturers are Wonderware, G.E./Intellution, and Rockwell Allen-Bradley.

B. Submit alternate manufacturers at least 10 days prior to bid date for review and approval.

2.02 DEVELOPMENT ENVIRONMENT **<Wonderware App Server>**

A. Multi-User Development Environment: The Development Environment shall provide simultaneous multi-user capabilities, where users are subject to security permissions based on individual system-wide roles.

B. Object Model: The Development Environment shall utilize the concept of Application Objects. These Objects may represent real world devices such as PID loops, Motors, Pumps, Valves, etc, or informational objects such as external database readers and writers, XML readers and writers, etc. Application objects shall closely model the physical representation of plant equipment and devices and not be bound to a “tag-only” topology. This shall include the ability to create complex, multi-variable data structures.

C. Object and Code Re-Use: The Development Environment shall promote code re-use through standard templates, which may be customized to create new object instances, while still maintaining parent-child relationships of the object definitions.

D. Object Repository: The Development Environment shall utilize a centralized repository for templates and application objects, object hierarchy, deployment configuration, and genealogy. It shall also provide the option to utilize the same repository for storage and management of the visualization application. The repository shall be used only for configuration and as such may be disconnected from a running system without affecting the runtime operation of said system.

E. Object Templates: The Development Environment shall provide a mechanism to develop Application Object Templates. These object templates shall be used to create the individual instances of the objects that perform the SCADA tasks. Object Templates shall be able to contain other object templates in a hierarchical relationship. Objects shall contain general object configuration, input/output definitions, internal attribute definitions, internal documentation for configuration help, user defined attribute definitions, alarm definition, history definition, and contained scripts. The Application Object shall be able to host associated graphic or graphics for representation in visualization. The Object Template shall allow the configuration of historical data storage without using a separate tool. The Object Template shall allow configuration of a connection to an alarm sub-system that supports condition-oriented alarms (LoLo, Lo, Hi, HiHi, Rate-of-Change Deviation, etc.), event-oriented alarms (True/False, Fail to Open, Fail to Close, Command Disagree, etc) with predefined tools that will step the developer through the process of defining the configuration. The Object template shall also support scripting. This

application logic shall be able to interface to tags and start and stop other application programs such as Microsoft Excel, Microsoft Word, Crystal Reports and other Windows based applications.

F. Object Template Derivation, Object Instantiation and Inheritance: It shall be possible to derive new templates from existing templates, base (supplied by the software manufacturer) or user defined. A derived template shall inherit the entire configuration of the parent object when generating a new template instance. Templates may contain other templates in a hierarchy. Derived templates shall maintain any hierarchy that the parent template contains. The Development Environment shall be able to lock specific attributes to allow changes to the parent template to pass through to the new instance and all children of the new instance.

G. Object Deployment: The Development Environment shall utilize the concept of deployment. Deployment shall be defined as the remote installation of any Application Object, its children, dependencies, and any other software required and bound by the Application Object for the Application Object to successfully operate. All instantiated Application Object components shall be configured and deployed from the Development Environment to target workstations and servers. The Development Environment shall provide visual feedback as to the deployed status of any Application Object and pending changes.

H. Import/Export Utility: The Development Environment shall support import and export of the application model into a human readable file format such as .CSV (comma separated file format) for editing in a spreadsheet application such as Microsoft Excel. It shall be possible to instantiate templates and application objects from the .CSV load by only populating the appropriate columns in the spreadsheet that are required for the instantiation/configuration of the desired objects.

I. All development and configuration shall be persisted in one or more common file or database repositories that provide single point of configuration. The development environment shall provide the ability to host and manage the visualization application in a common repository. Furthermore, there shall be a common naming convention for objects and tagnames that is enforced by the development tools. The software shall be licensed to support any of the following operating systems on appropriate hardware in any combination as follows: Windows XP Pro/XP Tablet, Windows Server or Windows Vista Enterprise, Business and Ultimate editions as well as thin client sessions hosted by disk or diskless PC’s

served byMicrosoft Windows Terminal Services. The same development environment shall be capable of designing visualization applications for use in selected Windows CE devices,

J. HMI Application Management: The SCADA system Development Environment shall be able to manage the visualization applications, as well as capabilities to distribute the selected HMI application(s) by deployment via drag and drop. Changes to a visualization application shall be propagated to any instances through the entire SCADA system. The SCADA system shall also include an application manager with a Windows Explorer-like browser to simplify management of client applications. The Application Manager shall provide the capability to dynamically change the resolution of the application windows. This will allow graphic displays to be developed on workstations with different display resolutions and convert them to the desired resolution quickly so that they are all consistent in look and feel.

1. Distributed Network Application Management: The SCADA software shall provide standard functionality that will simplify the configuration, operation, troubleshooting and maintenance of the application by providing means of easily distributing the application in network environments. The management software shall allow a single master application to be developed and maintained on the network. The Development Environment shall allow automatic distribution of the master application to all nodes on the SCADA control network as well as propagation of changes to the master application to all its instances in the system. When a client node is deployed an HMI application to it, the client shall maintain a copy of the application on its local hard drive and become registered as a user of that application. When a change to the template application is detected, each registered user node shall be notified of the change. The Design Environment shall allow the user to define how the client node is notified of the change in the application. The client node shall either automatically load the new application, prompt the user to load changes or ignore, or automatically ignore such changes. If a network failure occurs between the repository and client, then the client shall continue to run the last distributed application. When the network is restored and the server application has changed, the system shall distribute the server application to the client.

2. Application Log Files: Application log files shall reside on the local hard drive for a user-defined number of days. Each network node shall maintain an independent log file for the applications that are unique to each node. A new log file shall be created and archived daily according to the user specified time and location. The viewer shall support color distinctions for different threads, processes or programs. The log file viewer shall support viewing remote node application log files.

2.03 HMI DEVELOPMENT REQUIREMENTS

A. Graphics Display Development: The SCADA system software shall include an object-oriented color graphics display generator with full animation capabilities to provide users with a realistic visualization of the SCADA system process.

1. Graphical Objects: The graphics editor shall include a set of basic drawing tools to create simple or complex objects. Text objects shall be scalable and use true fonts in bold, italic or underline. All objects shall be scalable and moved in any direction one pixel at a time or dragged with a mouse. A minimum of 48 predefined colors shall be provided. System must also support the user choosing transparent or gradient colors for all graphical objects and backgrounds.The graphics editor shall support standard object manipulation functions such as cut, copy, paste and delete. Alignment tools shall be included to simplify proper placement and arrangement of objects. The graphics editor shall be able to modify a member of a group without breaking the group. The graphics editor shall include a broad library of complex objects and process symbols such as meters, pushbuttons, sliders, gauges, pumps, motors, tanks, valves, trends, alarms, controller faceplates and bitmaps. All complex objects shall be scalable to any size and may include animation links to provide dynamic response based on real time data or user action. The color of graphical symbol may be changed dynamically by boolean, analog, or string references. Percentage of fill for objects up, down, left or right direction based on a tagname/hierarchical Name. Blinking, size, location, and orientation animation must also be supported. The system shall support the import of .DXF files with the drawing elements imported as native objects. It shall be possible to animate these objects using the full set of object animation properties. Graphics editor shall also allow the user to import drawings and images in BMP and

JPEG file format.On-line context sensitive help shall support display building. Users shall be able to obtain immediate help on all configuration subjects by pressing a single function key. The user shall be able to define graphic screens while the system is monitoring the process. The user shall be able to distribute the visualization application and/or changes to single or multiple nodes at will.

2. Graphical Applets: Application developers shall be able to create resolution independent self-contained graphical “applets” with integrated scripting, their own namespace and custom attributes. The graphical applet scripting shall consist of an OnShow, On Hide, While Showing (periodic), and user defined and named On True, On False, While True (periodic), While False, and Data Change .NET scripts. The Application Developer shall be able to define local and external named attributes of the following data types: Integer, String, Boolean, Float, Double, Time, and Elapsed Time.

3. Graphical Applet Manager: Using a Graphical Applet Manager, application developers shall be able to create groups of graphical symbols that then comprise a single named Symbol that may be expressed as a named Template. There shall be no practical limit to the number of graphic symbols that can comprise a single Compound Symbol, up to, and including an entire window of symbols. These templates shall connect either to Object Database objects, to local HMI tags or to HMI tags through remote references. Changes to the Graphical Template shall propagate to all instances of the template. Libraries of re-usable Graphical Applets may be created, organized and managed using the Symbol Manager.

B. Alarm Summary/Alarm History Object: Alarms shall be displayed by configuring a user-defined alarm summary object, which may be placed by itself or along with other objects in a window. The object can be sized and then doubleclicked to launch a configuration dialog. Default alarm object configurations shall be displayed with the option of changing any configuration parameter for runtime viewing. The alarm object configuration shall include parameters with check boxes to select and enable or disable how the alarms appear at runtime. Alarms shall be color coded according to the state and priority of the alarm including an acknowledged alarm, unacknowledged alarm, and an alarm that has returned to normal but is not yet acknowledged. The user shall be able to

choose from multiple different colors for display of each of these alarm states. The alarm display object shall also support event display, with the color used for events also being one of the various different colors.

C. .Net Control support: The SCADA software shall provide extensibility by providing integrated support for .NET controls. The system shall automatically distribute .NET assemblies and dependencies to client nodes during the publish/deployment process.

D. HMI Application Control Logic: The SCADA system software shall include a scripting language that allows execution of commands and mathematical and logical operations based on specified system conditions or user actions. The scripting shall be easy to program using English-like statements and shall not require any knowledge of any other programming logic. The user shall be able to edit or modify the logic scripts while the system is monitoring the process. Furthermore, it shall not be necessary to invoke any other application to compile the changes. The scripting language shall include selection boxes and pull-down menus to permit statements to be created without having to type tagnames or specific commands. A validate button shall be included to ensure proper syntax and provide indication of errors to eliminate any problems at runtime. On-line help for each script function shall include actual working examples that can be copied and pasted into the script editor.

E. HMI Function Logic: The system shall support creating of logic blocks and saving the logic as a function. These function scripts shall be capable of running on a process thread independent of the HMI process. Function scripts shall run on a separate process thread and not impact the performance of the HMI operations. Function scripts shall be able to be called from any of the logic types defined in earlier sections including a call from a function script to another function script.

2.04 RUN-TIME ENVIRONMENT

A. Alarm Management: Alarms shall be logged to a Microsoft SQL Server. Alarm events to be recorded shall include alarm instantiation, alarm return-to-normal, and alarm acknowledgment. Items to be logged in addition to the alarm event shall include date and time of alarm event, Alarm Group, Alarm Tagname, Alarm Tag Type (real/integer/boolean), Alarm Type (LoLo, Lo, Hi, HiHi, ROC, Deviation, disc, etc), Operator Name , Operator Node of alarm acknowledgement, and Alarm Priority. Alarms shall have the capability to be printed to a locally connected or

network printer, or emailed to the appropriate person. The alarms printed from a particular node may be all alarms, only unacknowledged alarms, only acknowledged alarms, alarms from a particular alarm group or groups, alarms from a particular priority to a particular priority or alarms from multiple alarm providers.

B. Communications Architecture: The run-time environment shall be based on distributed, peer-to-peer system architecture. The architecture shall contain a multi-computer model that is seen as a single distributed namespace in the run-time environment and does not require replication of data from one node to another. Application Objects and their attributes shall be accessible by the objects Hierarchical Names, or globally unique tag names. The architecture shall operate in real-time and be able to handle millisecond transaction and event speeds. The architecture shall be able to monitor and respond to high volumes of asynchronous data and event messages at a rate of thousands of messages per second. It shall be capable of supporting at least 3,000 I/O and 50 nodes. Application Objects shall have the ability to connect to any IO server utilizing the Suitelink or OPC protocols. IO shall be defined as any input and/or output variable, including individual data acquisition points and any variable parameter generated for exchange between objects in the system. At a minimum, the data types that shall be supported are Boolean, Float, String, Internationalized String, Integer (8, 16, and 32 bit, signed and unsigned), Time, and Elapsed time.

C. Runtime Data Viewer: The system shall provide a utility to view the real-time status of any Application Object Attribute.

D. SCADA System Failover: Provide hot-backup redundancy. The specific components that require redundancy within the SCADA system are visualization graphics, alarms, communications, and data historization. High availability requirements also apply to logging of historical process data. In redundant failover configuration, there shall be a Primary and a Backup system object that manages contained Primary and Backup objects. The system shall execute active objects and synchronize active objects with standby objects. In the event of detection of any failure in active object execution or communication with the active object, standby objects shall begin executing and communicating within the system. The system shall include automatic synchronization when the failed node is repaired.

E. RTU/PLC and DCS Communications Server: The SCADA system shall include broad range of communications servers for establishing the I/O interface between field devices such as RTU’s, PLC's, DCS systems and the data historian. General Purpose I/O Communications Servers General-purpose communication I/O servers shall be available for all major PLC’s from Allen Bradley, GE, Modicon, or Siemens.. There shall be support for several hundred various devices utilizing the protocols of Suitelink, and OPC.

2.06 SECURITY

A. The Development and Runtime Environments shall be capable of utilizing Microsoft operating system security, for example Active Directory Domains, to allow users access to view, configure, or modify templates and Application Objects. The security system shall support an object based, hierarchical model. This model shall allow for the creation of Security Groups that contain assigned Application Objects. The model shall allow for the creation of Operator Roles that can be assigned to Security Groups. Operator Roles shall allow for the assignment of configuration database permissions, and for runtime operational permissions, and access to visualization of certain windows. At a minimum, runtime operational permissions shall allow for:

1. The access or denial of the ability to acknowledge an alarm in the runtime environment.

2. The modification of configuration attributes which allows users to configure the attribute’s value (for example, a PLC register that defines a discrete input).

3. The modification of operational attributes which allows users with operational permissions to do certain normal day-to-day tasks like changing setpoint, output and control mode for a PID object, or commanding a Device object.

4. To open and view a process or application window.

5. The modification of tune attributes which allows users to tune the attribute in the runtime environment. Examples of tuning are attributes that adjust alarm setpoints and PID sensitivity.

B. Users assigned to Operator Roles shall inherit all parameters that were assigned to the Role and Security Group. Runtime changes to object

values shall be subject to security authorization. Permissions that are configured using the Development Environment shall be automatically checked at runtime for authorization including verification of identity and access permission related to the originator of the runtime change request. Users shall log in before any change to any object attribute that has been constrained is allowed. The runtime architecture shall conform to the object attribute security model defined in the configuration environment. The manufacturer must have published security guidelines to assist in securing the entire SCADA system.

C. Audit Trail: The Development Environment shall provide an audit trail of Check Out/Check In, and revision history for each template or application object that includes user ID, time and date stamp, and a detailed summary of the changes made. Any runtime changes to a variable so configured shall provide an audit trail of user ID, full user name, previous value, and new value. Attributes configured for Verification shall provide an audit trail of user ID, full user name, verifier username and full user name, previous value, and new value.

2.07 Full Function Operator Workstation (HMI): The SCADA system operator shall be able to execute all monitoring and supervisory control functions from this workstation. The operator shall be able to access all SCADA tagname/hierarchical names or graphic displays from any workstation on the network without having to know which data historian or server the point or display resides on. The system software shall include an object-oriented color graphics display generator with full animation capabilities to provide users with a realistic visualization of the system process. This workstation shall utilize the Server 2016 operating system. All SCADA software shall support running as a windows service so that following a power failure or when the machine is turned on, an automatic start-up to the runtime mode will occur. All operator actions shall be logged to an event logger.

2.08 Reporting/Trending Software: The SCADA system software shall include a set of easy-to-use client software tools for real-time and historical data analysis and system reports. Users shall be required to log in with a password to access the database server. The user shall not have to know the location of the server on the network, only the name of the server. The data analysis software shall include tools for advanced trending analysis, X-Y plotting of tagnames, and viewing of reports in spreadsheet or free form format. The client tools shall be available as a stand-alone program or as .NET control for embedding into the SCADA displays so that any full function or view only operator workstation may have the same capability, or any user interface that supports .Net.

A. Real-Time and Historical Trend Analysis Tool: A client tool shall be included that allows users to view any or all of the tagnames in either a trend chart or tabular format. The client tool shall have a user interface that allows for easy selection of tagnames using a Windows Explorer-like browser with a search filter to quickly find tagnames in a data historian with thousands of points. The user shall be able to create folders for selected groups of tagnames and plot them individually or in groups by dragging them into the trend area. The user shall be able to save trend files for recall at a later time. It shall be possible for the user to switch from the real time to the historical viewing mode using a simple check box. The user shall be able to toggle from viewing trends either in the superimposed or the stacked mode. In the superimposed mode, all trends overlap and are in a single scale range based on the largest vertical scale range in the group. In the stacked mode, each trend has its own vertical scale range. Trend plots shall automatically be scaled based on the widest vertical range of the tagname or optimized based on the maximum and minimum range within the selected time period.

1. Real-time Trend Viewing: The user shall be able to trend up to 256 different tagnames in real time including analog, discrete, string or event tagnames within the same trend. The user shall pick tagnames from the browser. The time span and vertical range of the trend shall be user configurable at run time. Standard time spans shall be configured for the last 5, 10, 30 or 60 minutes or the last 2, 4 or 8 hours. The user shall be able to adjust the range of the tagnames in run time.

2. Historical Trend Viewing: The user shall be able to plot historical data for any tagname or groups of tagnames in the database based any user-selected start and stop time. Two hairline cursors may be turned on and dragged across the trend area to provide the user with the exact value for each trended tagname at the point of intersection. The time span and the value between the cursors shall also be displayed. It shall be possible to overlay data from different start/end times to compare the performance of equipment / compare the process for different time intervals. It shall be possible to overlay ‘live’ trends onto history traces to compare performance. The trend tool shall display statistical data for each trended analog tagname within the time period selected. Statistical values shall include the minimum, maximum, average, and standard deviation. Icons or menu pull down commands shall be available for analyzing

the data such as horizontal, vertical or rubber band zooming pan left or right and zoom between the hairline cursors. It shall also be possible for the user to create text annotations anywhere on the trend. These annotations shall be visible from other workstations on the network with the same trend tool. It shall be possible to export the data in the trend area into a CSV file. Printing of the trends with all statistical data shall be supported.

B. .NET Tools: The data analysis software shall provide .NET objects for the Trend and Query clients so that they may be embedded into SCADA HMI or any other .NET container. A query client shall be included to allow the user to execute SQL queries that returns a result set from any SQL server database into a tabular data grid. The query .NET tool shall support multiple data server sources for simultaneous display of the data. An .NET trend object shall also be provided.

C. Excel Reporting Tool: The data analysis software shall be included that allows users to easily select tagnames and historical values from the real time or historical database via a browser and then utilize them in a standard Microsoft Excel spreadsheet for reporting or presentation to management. The selection of tagnames shall be accomplished by use of drag and drop or point and click commands. It shall not be required to write any macros to retrieve the data. The tag values selected can be output to specific cells in the spreadsheet and processed as number data types. The user shall be able to select historical data for the most recent values or go back and select any start or stop time as far back as the data is available. The historical data can be recalled at the granularity that it was stored or in a selected number of data points over a period of time. The user shall be able to retrieve raw historical data or summarized data such as the minimum, maximum or average over a predetermined time period. Updates to the current values once they are in the spreadsheet shall be refreshed with a single click of the mouse. The quality of the data shall be analyzed and displayed. The user shall be able to select if poor quality data is to be displayed or replaced with an interpolated value. The user shall be able to specify relative or absolute value choices.

2.10 View-only Graphics Display Capability: The SCADA system software shall include a minimum of (2) simultaneous view-only HMI client licenses for remote access. No modifications to the SCADA HMI configuration shall be required for this functionality. The view only graphics display HMI shall be capable of running in a terminal services session. Provide Microsoft terminal services licensing as needed on both servers.

2.11 DATA HISTORIAN

The SCADA system software shall provide a real-time relational database historian for long-term storage of process data. The Data Historian shall provide for the storage of real-time and historical data for each analog, discrete or string tagname. The data historian shall also store summary, event, alarm and configuration data. The database engine for the historian shall be based on a full licensed copy of Microsoft SQL Server and supports client/server architecture. The user shall not be required to know Microsoft SQL Server to install and implement the historian. The data historian database shall acquire and store process data at full resolution. The data historian database shall include normalized extension tables for real time data and include a set of client tools for data analysis and reporting such as those described in earlier sections. The Data Historian shall be capable of running in a stand-alone mode without connection to, or configuration from, the SCADA system While there are always physical limiting factors such as disk space, there shall be no programmatic limit to the amount of data that may be stored on-line. Additionally, there shall be no performance penalty for long-term data storage. There shall be no discernable difference in retrieval speed of data based on the age of the data. For example, the retrieval of two hours data stored two years prior shall be the same as for two hours of data stored one day ago.

A. Data Compression: The database shall support high-speed data acquisition and efficient data compression. The data compression for the data historian shall not use any algorithms that do not allow for the storage of the tag data at their scanned rate. The stored data records shall be able to recreate the process data in a loss-less format. The following are the data storage requirements: Discrete Storage Requirements - 7 bytes max. Delta or Cyclic analog storage - 10 bytes max. Database shall be capable of storing string, or text, data also with quality field.

B. Standardized Database Tables: The process of setting up the database tables shall be automatically configured and require no database engineering. Data definitions including the creation of database objects, such as tables, indexes, constraints, defaults, rules, stored procedures, triggers, and views shall follow a standard, published and readily available database schema. This standard database schema shall outline the relationship between tables, table columns, keys and indexes and shall allow for third party development of client applications. Database device sizes shall be dynamically allocated during database installation depending on the number of tagnames to be stored within the data historian.

C. Single Configuration of Data Historization: The historization of data from SCADA objects shall be entered once at the time of configuration of those objects using the corresponding object editor in the SCADA System. The Data Historian shall automatically acquire those configuration historization parameters upon deployment of the configured Application Objects

D. Historical Data Store and Forward: If the Historian is off-line or unreachable, the engines servicing active objects shall store the historized data locally, and forward the buffered data to the Historian when the historian server is available.

E. Historical Data Point Configuration: The data historian shall include a database editor to modify the parameters of any tagname without using the SCADA database editor as an option. It shall be possible to configure the data storage rate for each point based on a user-defined rate frequency (cyclic storage) or upon change (delta storage). Cyclic storage rates shall be configurable per point from 1 second up to hours. The historian database shall support a 5-millisecond resolution for tagnames configured with delta storage.

F. Historian Data Acquisition and Retrieval: The data historian shall acquire data via automatic and manual methods. Automatic data acquisition shall be through industry-standard data transports. Data Acquisition via Dynamic Data Exchange (DDE) and OLE for Process Control (OPC), in addition to proprietary transports, shall be supported. The method for retrieving data shall be Structured Query Language (SQL). It shall be possible to store data at one resolution and query at another. Methods shall exist to query and retrieve data cyclically, with millisecond resolution, no matter the storage mode. It shall be possible to query and retrieve data in delta, with user selected dead-band criteria and millisecond resolution, no matter the storage mode. It shall be possible to query and retrieve evenly spaced data over long periods of time where the criteria are a row count, no matter the storage mode. The historian shall automatically begin to acquire tag data immediately after a tag configuration has been committed to the database. Adding a single or multiple tags to an existing historian database shall not affect the data acquisition of previously defined tagnames. Client connections shall not be affected during reconfiguration due to dynamic configuration. Additionally, there will be no loss of data for tags where data acquisition configuration is not changed. Tags that require a change in data acquisition configuration will obviously lose data during the period of their re-initialization. The historian shall support Manual Data, Out-of-Sequence Data, and Superseded Data.

Manually entered data such as Lab Data and Out-of-Sequence Data such as batched history data from a Remote Terminal Unit (RTU) shall be treated by the retrieval engine as if the data were stored automatically. Any historized data may be superseded by manually inserting the correct data value and a flag denoting that the previous data has been superseded. The original data shall not and cannot be modified or destroyed. An SQL client tool may request original data, superseded data, or both. Manual Data, Out-of-Sequence Data, and Superseded Data shall be inserted into the Historian via an SQL Insert statement, or in bulk via Comma Separated Variable (CSV) file. Only users with proper login credentials shall be allowed to manually insert or modify data. All stored data shall contain data quality attributes. The primary Data Quality attribute shall reflect Data Quality as defined in OLE for Process Control (OPC). Additional quality attributes shall be used for initial data (startup flag) and superseded data.

G. Event System Configuration: The data historian shall contain an event sub-system to monitor, record, and or respond to process or system events and to trigger some type of action when the event is detected. The event system shall detect an event occurrence using pre-defined and configurable criteria; historically log when an event occurs and trigger designated configurable event actions based on the event detection. Event attributes shall be logged to the database and shall include the date, time that the event occurred, and the event criteria that were satisfied.

H. Database Summary System: The data historian shall provide user configurable data summary tables for any analog tagname and to automate the collection of aggregate historical information based on a declared event. The summary system shall support minimum, maximum, average and summed calculation types for Minute, Hourly, Daily, Weekly and Monthly frequencies. The summary system shall store the tagname, value, type of calculation, and frequency as defined for each tagname.

I. Historian Interface to Other Relational Databases: The data historian shall utilize Microsoft’s Data Transformation Services to simplify the transfer of historical process data with other SQL Server databases like Microsoft SQL Server or Oracle. The historian database shall include an OLE DB Provider (Object Linking and Embedding for Databases) so that any other SQL client can access the real-time or historical process data from the data historian.

J. Disk Storage Management: The data historian shall not require specialized tools for disk storage management. It shall be possible to archive and retrieve historical data files using standard Windows® copy techniques. It shall be possible to retrieve select portions of archived data without retrieving all archived data. Retrieval of the archive data shall automatically place this data on-line and available for retrieval by the data historian. Additionally, the data historian shall approach zero-administration as nearly as possible. The data historian shall provide for a mechanism whereby current files on a disk drive that is nearly full will automatically be moved to a secondary device. The files and available space on the secondary drive shall be monitored as well such that when a user-defined threshold is reached, the oldest files may be automatically deleted to preserve the integrity of the system. Historical files shall never be deleted from the primary storage device if an appropriate secondary device is configured.

2.12 Software Warranty, Maintenance and Support

The software vendor shall provide software maintenance and support program to ensure that the user receives full benefit of the software for the duration of its life cycle. The program shall provide for basic warranty coverage and include an extended warranty for priority support and software upgrades as they are released. Telephone support shall be available through a toll free number during normal business hours. Support shall also be available via fax, email or through a technical support website.

A. Warranty Support: The software shall be warranted for the period of time referenced in the General Conditions of the Contract and Section 17010 – one year from the date of Substantial Completion. During the warranty period, the vendor shall offer free technical telephone support during normal business hours through a toll free number. All software defects shall be resolved in a timely manner. The Warranty shall include not only the repair of defects but also software upgrades, priority telephone technical support, email technical support, and electronic file downloading of all updates, patches, drivers, etc.

B. It is required that the Software maintenance and support agreement last at least one year after Substantial Completion of the Contract. The Contractor shall include the number of years of manufacturer’s extended warranty in the Bid as required to comply with this.

2.13 SOFTWARE BACKWARD COMPATIBILITY

The software vendor shall have a track record of software backward compatibility and continuous migration path in order to protect engineering investment. Old applications shall be able to be easily migrated to the newest versions of the software.

PART 3 - EXECUTION

3.01 SOFTWARE SERVICES

A. General: Software services shall include program development, testing, documentation, and work necessary to implement a complete and fully operating system as shown on Drawings and as specified. Work requires coordination with concurrent program development for programmable controllers (PLCs), Operator Interfaces, Management Reports, and Data Collection. Include PLC error detection logic for communications failures, data highway faults, internal faults, and time outs. Communicate PLC error conditions to Operator Interface for logging and reporting. Communication between PLCs, Operator Interface, and Data Collection shall be on an exception basis. Employ a "watchdog" timer for each remote PLC and poll that PLC if no message has been received in a reasonable amount of time. Accept Operator Interface directives for set point changes and hand switches.

B. Programmable Controller Logic: Develop programs for execution on PLC using development software supplied under that Section. Logic shall perform functions required to control processes and equipment as shown on Drawings and/or as specified. Develop complete cross-references for ladder logic and complete input/output listings.

C. SCADA Interface Screens: Provide graphic representation of plant processes and control over machinery. Also provide data collection activities to provide historical trend analysis and process data readings for use in management reporting. Provide the following screens as a bare minimum:

1. Main Menu
2. Overall Plant View
3. Raw Water Intake
4. Chemical Feed
5. Flocculation & Sedimentation
6. Filtering
7. High Service Pumps

8. Alarm Detail
9. Alarm History
10. Network Status
11. Trending
12. Power Monitoring
13. Elapsed Run Time Reports
14. Flow Total Reports
15. Plant Autostart Selection

D. SCADA software required application features:

1. Video displays shall be color at either 1080p resolution. Install operating system drivers as necessary. They shall be fully windowed and shall use a mouse for control. Use colors, function keys, and navigational controls consistently.

2. Alarm Management: For each process or system event classed as an alarm provide facilities for displaying and logging in database, acknowledgment, and purging of stale messages. Alarm events are derived from discrete inputs, analog trip values, logic combinations and computations as needed. Log and display both alarm events and returns to normal. Provide date/time stamps for events, descriptive message, and event type code. Use color combinations to distinguish following alarm states: Alarm-Unacknowledged, Alarm-Acknowledged, Normal-Unacknowledged, and Normal-Acknowledged.

    a. For each piece of equipment that is called to run by a controller and has a status feedback signal, provide a “Failure to Start” alarm that triggers 5 seconds after the equipment is called to run if it is not confirmed to be running by the feedback signal.
    b. For each 4-20mA instrument, provide a “Transmitter Failure” alarm that triggers if the signal falls below 3.8 mA or exceeds 20.2 mA. This alarm shall not be triggered if a power outage occurs.

3. Graphic Displays:

    a. Provide process-oriented displays showing current process status and accepting operator input for setpoint and status changes.
    b. For each display, show process elements such as pumps, valves, tanks, pipe lines, etc., with their current operational status. Emphasis shall be placed on depicting the plant in a “P&ID” format that allows easy conceptualization of process flow rather than depicting equipment in actual physical location or

scale.

c. Not running state: graphic shall be natural color with no motion.
d. Running state: Graphic shall be green color and shall rotate or show other type of motion as appropriate. Both color and motion shall be depicted.
e. Red color shall be reserved for alarm graphics.
f. Tanks shall include both analog and digital indication of current fill/level status. Also, static text must be added to indicate level at bottom of tank and top (or overflow) of tank.
g. Indicators shall use an appropriate number of significant digits and dead band to produce steady values.

4. Print Screen function shall direct an image of the currently displayed screen to any system printer as the user directs. When directed to a color printer, a color screen image shall be produced.

5. Trending: Provide on-screen trending displays that are user definable that operate from either previously collected historical trend groups (named file) or from a group of real-time variables. Provide facilities for user selection of colors, time (horizontal), and measurement (vertical) scales. Accommodate real-time sampling intervals as short as 1 second. Real-time trends shall show alarm setpoints. Historical trend displays shall have time-scale panning controls. All trends must have an adjustable cursor that indicates both Y and X axis values at the user-selected location.

6. Security: Using operator interface and operating system software, implement a security system to restrict access to parts of system. Provide the following as a minimum:

    a. Programmer - Access to all facilities including changing displays and logic.

    b. Supervisor - Access to all displays, change master set points and purge stale alarm messages.

    c. Operator - Access to all displays, change normal operational sequences and acknowledge alarms.

    d. Guest - Access to displays only.

7. Data Storage:

    a. Data shall be stored to the Historian’s database. Text, binary, or otherwise “flat” file storage is not acceptable.

b. All tags, both analog and digital, shall be stored via “Delta” storage method. That is, a new value shall be stored only when the tag has changed an appropriate amount. Normally the delta storage should be triggered at 0.1% change against the tag’s maximum value, although this level may need to be adjusted if the tag has an abnormally wide range of operation.

c. Establish automatic backup of historical data on a daily basis. The data shall be stored on an external harddrive provided by the Contractor unless noted otherwise on the Drawings.

8. Trending

a. For each tag selected to be trended on the Contract Drawings, provide a pre-configured trend that shows both real-time and historical values. Certain tags may be added to the same trend where appropriate as long as they are uniquely identified via color and label.

b. Provide a custom trend screen whereby the operator has the ability to trend any tag in the database.

9. Reports:

a. Reporting requirements shall consist of both live HMI screens that dynamically update the values for “today” and also published historical reports. The published reports shall be accessible via web browser across the internet with appropriate security.

b. Daily totals shall be published at 11:59:55 PM and reset to zero at midnight. Monthly totals shall be published at 11:59:55 PM on the last day of the month and reset at midnight.

c. Totalization time slices shall not exceed 5 seconds.

d. The following parameters shall be reported:

i. Motor & Equipment Run times: For each motor or piece of equipment that is monitored, report “Run Time Today” and “Run Time Yesterday”.

ii. Flow Totals: For each flow meter, report “Flow Total

Today", "Flow Total Yesterday", "Flow Total This Month", and "Flow Total Last Month."

e. Data Export: Establish a simple method of data export to Excel.

3.02 CONTROL SEQUENCES

A. General

1. Provide programming of control sequences to control equipment and processes.

2. All equipment indicated to be controlled in the SCADA I-O table shall have hand, manual, and automatic modes of operation. Hand mode shall be independent of the SCADA system (example: operator turns on a motor using the Hand switch on the MCC). In manual mode, the operator shall be able to start the equipment. In automatic mode, the equipment shall run when the plant is turned on if it is selected to run on the autostart screen. Special cases are described below.

B. Plant Autostart Control

1. Provide a selection screen that determines which equipment will run when the plant is started. This matrix shall include the raw water pumps, flash mixers, flocculators, grit system, and chemical pumps.

2. Provide setpoints for the river water and spring water flow rates.

3. Provide a main plant "Off/On" autostart switch. When the switch is turned on, then the equipment selected in the autostart control screen shall be started. Provide appropriate time delays in the PLC logic.

C. Raw Water Valves

1. Provide Manual and automatic modes of operation. In manual mode, operator shall be able to set the % Open position of both the spring water and river water valves.
2. In automatic mode, provide PID loop control of valve position for both valves with flow setpoint adjustable by the operator. Provide tuning of the PID loops to ensure stable, accurate control with fast response time and little-to-no overshoot.

D. Grit System

1. Provide an On-Off-Automatic software switch. In the “On” position, both the grit valve and the flush valve shall be opened.

2. In the automatic position, the two valves shall be opened and closed periodically according to timers as long as raw water is flowing and the grit system is enabled on the autostart screen. Provide an “Open Time” timer and a “Close Time” timer that are adjustable by the operator.

E. High Service Pumps

1. High service pumps shall be manually-controlled only by the operator. They shall not be part of the plant autostart sequence.

2. Provide start/stop manual switches in the software for each high service pump.

3. Provide adjustable speed command setpoints for each of the new high service pumps with frequency drive.

3.03 PERFORMANCE TEST

A. Following installation, checkout, and final adjustment of software, the Contractor shall schedule a performance test in the presence of the Engineer and the Owner.

B. Demonstrate to the Engineer and Owner that each I/O point scheduled on the Contract Drawings has been integrated and is functioning properly.

C. Demonstrate trending, reporting, and alarm messaging has been configured properly and is operational.

D. Software development shall not be accepted until the SCADA system functions for at least one week with no more than 3 nuisance alarms. Nuisance alarms shall be as defined by the Owner.

END OF SECTION

SECTION 17610

ELECTRIC VALVE ACTUATORS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide valve actuators as indicated on the Contract drawings and as specified herein. The actuators shall be factory-installed onto the valves and tested and shall be shipped as a complete assembly.

1.02 RELATED WORK

A. Division 15 - Valves

1.03 SUBMITTALS

A. Shop drawing approval is required. Valve and actuator submittal shall be combined into a single submittal. Include complete wiring diagrams and electrical information.

B. Operation and Maintenance Manuals shall be submitted in accordance with Section 17010.

1.04 QUALITY ASSURANCE

A. See Section 17010 for requirements.

B. Actuators shall comply with AWWA C540.

1.05 WARRANTY AND SERVICE

A. See Section 17010 for requirements.

1.06 TRAINING

A. Training shall be in accordance with Section 17010.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Acceptable manufacturers for large motorized actuators shall be Limitorque, EIM, Auma, or equal.

B. Acceptable manufacturers for smaller actuators shall be Hayward or equal.

2.02 LARGE VALVE (6” AND LARGER) ACTUATOR CONSTRUCTION

A. Actuators shall consist of an electric motor, worm gear reduction, electronic torque sensor, mechanically and electrically interlocked reversing motor contactor, electronic control, protection, and monitoring package, manual override handwheel, valve interface bushing, LCD (Liquid Crystal Display), and local control switches. Actuator design life shall be at least one million drive sleeve turns.

B. Actuator Housing: Actuators installed above grade shall be NEMA 4X. Actuators installed below grade shall be NEMA 6P & IP-68 rated to 15 meters for 96 hours. Actuators proposed for hazardous areas (as indicated on the Drawings) shall be FM certified for the indicated hazardous area.

C. Actuators indicated as two-position actuators shall have limit switches to indicate position status. Modulating actuators shall have an absolute position encoder and shall accept 4-20mA input position control signal and shall generate a 4-20mA position feedback signal.

D. The power transmission shall be completely bearing-supported, and consist of a hardened alloy steel worm and bronze alloy worm gear; oil-bath lubricated using synthetic oil designed specifically for extreme pressure worm and worm gear transmission service.

E. The actuator voltage rating shall be as indicated on the Drawings. If the voltage is not indicated on the Drawings, the actuator shall be 120V single phase for valves 16” and less, and 208-230/460V three phase for valves over 16” in diameter. The motor shall have Class F insulation and a thermistor embedded within the motor windings to prevent damage due to overload. The motor shall be easily removed through the use of a plug-in connector and shaft coupling. Valve motors shall be listed for continuous duty operation.

F. An electronic torque sensor shall be included. The torque limit may be adjusted from 40-100% of rating in 1% increments. The motor shall be deenergized if the torque limit is exceeded. A boost function shall be included to prevent torque trip during initial valve unseating and during extreme arctic temperature operation (-50°C), and a “Jammed Valve” protection feature, with automatic retry sequence, shall be incorporated to de-energize the motor if no movement occurs.

G. A Phase Correction circuit shall be included to correct motor rotation faults caused by incorrect site wiring. The phase correction circuit shall also detect the loss of a phase and disable operation to prevent motor damage. The

monitor relay shall trip and an error message shall be displayed on the LCD screen when loss of phase occurs and indicate the fault for Remote operation.

H. A monitor relay shall be included and shall trip when the actuator is not available for remote operation. Both N/O and N/C contacts shall be included, rated 125VAC, 0.5A and 30VDC, 2 amps. The monitor relay shall be configurable for three additional fault indications; lost phase, valve jammed, and motor overtemp. The yellow LED shall blink when the monitor relay is active.

I. A padlockable LOCAL-STOP-REMOTE switch and an OPEN-CLOSE switch shall be included for local valve actuator control. The control switches shall not penetrate the controls cover and shall be designed to electrically isolate the actuator's internal components from the external environment. The OPEN-CLOSE switch may be configured for maintained or push-to-run (inching) control.

J. Double sealed terminal compartment & Terminal block - All customer connections shall be located in a terminal chamber that is separately sealed from all other actuator components. Site wiring shall not expose actuator components to the environment.

K. Coatings - The actuator shall be coated with a polymer powder coat. The coating system shall be suitable for an ASTM B117 salt spray test of 1500 hours. External fasteners shall be stainless steel or high-strength carbon steel that has been chromate-hexavalent coated, and then top coated with a high-strength, high-endurance polymer. The fasteners shall be suitable for an ASTM B117 salt spray test of 500 hours.

L. A handwheel and declutch lever shall be provided for manual operation. The handwheel shall not rotate during electric operation nor can a seized motor prevent manual operation. Changing from motor to manual operation is accomplished by engaging the declutch lever. Energizing the motor shall return the actuator to motor operation. The lever to enable the declutch shall be padlockable to permit motor operation only.

M. The actuator shall include a removable torque or thrust bushing to mate with the valve shaft.

N. Factory testing - Every actuator shall be factory tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of rotation, micro-processor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with the actuator.

O. Actuators to be installed outside shall include an internal anti-condensation heater.

2.03 SMALL VALVE (4” AND LESS) ACTUATOR CONSTRUCTION

A. Actuator shall be designed for corrosive environment with glass-filled polypropylene housing. Hardware shall be 303 stainless. Enclosure shall be NEMA 4X and IP-67 rated. Power supply shall be 120VAC and actuator shall include integral thermal overload protection. The actuator shall be listed for ambient temperature operation from 4 to 160°F. Cycle time shall be no longer than 30 seconds. Actuator shall include an internal anti-condensation heater.

B. Actuator shall have a standardized mounting base and shall be installed and tested with the valve prior to shipment to the project site.

C. Actuator shall include a position indicator and a minimum of two limit switches indicating fully open and fully closed status.

D. Actuator shall include a manual override and position indicator.

E. Actuator shall include a status indicator that indicates power status and fault status.

F. Where indicated on Drawings, actuator shall include a digital positioner with 4-20mA input signal.

G. Where indicated on Drawings, actuator shall include a battery fail-safe kit that will drive the actuator to the safe position upon power failure.

H. Actuator shall be Hayward ECP series or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the valve and actuator per manufacturer’s instructions.

B. Test to ensure proper operation.

C. For modulating actuators – tune control loops to achieve stable operation with reasonable response time and accurate setpoint control.

END OF SECTION