CITY OF FLINT, MICHIGAN
DEPARTMENT OF PURCHASES & SUPPLIES

PROJECT MANUAL FOR

CHEMICAL SYSTEMS FEED BUILDING

City of Flint Bid No. P20000550

October 18, 2019

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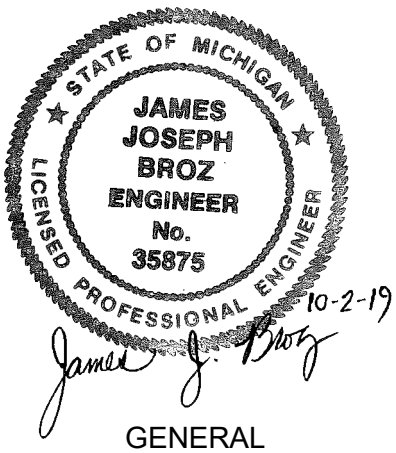
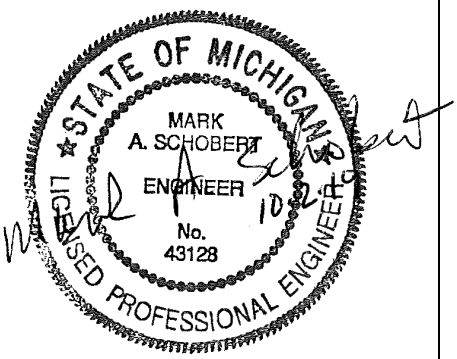
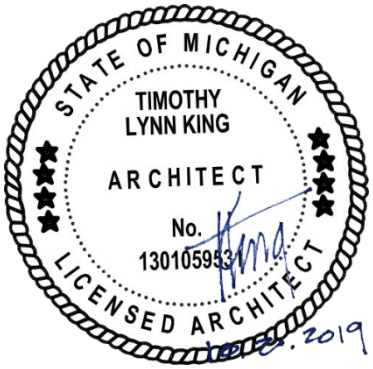
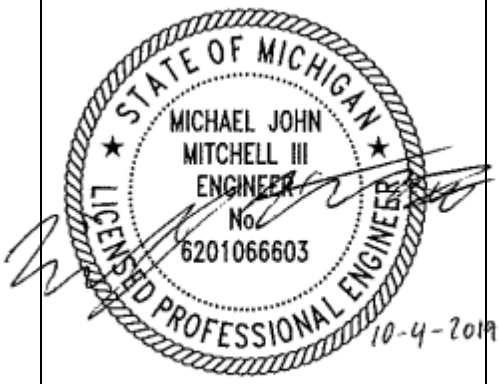
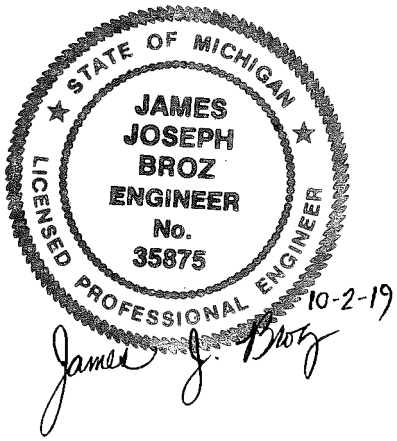
CITY OF FLINT

CONTRACT DOCUMENTS
FOR
CHEMICAL SYSTEMS FEED BUILDING

October 9, 2019

 GENERAL	 CIVIL	 ARCHITECTURAL
 STRUCTURAL	 PROCESS-MECHANICAL	 HVAC/PLUMBING/FIRE PROTECTION

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CDM MICHIGAN INC.
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DETROIT, MI 48226
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Digitally signed by Vincent Plansky Date: 2019.10.02 11:25:11-05'00' STATE OF MICHIGAN VINCENT N. PLANSKY ENGINEER No. 6201043535 LICENSED PROFESSIONAL ENGINEER ELECTRICAL	STATE OF MICHIGAN JOHN M. ROBINSON ENGINEER No. 6201069387 LICENSED PROFESSIONAL ENGINEER 10-9-19 INSTRUMENTATION AND CONTROLS	

CDM MICHIGAN INC.
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SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 LOCATION OF WORK

A. The work of this Contract is located at the City of Flint Water Treatment Plant (WTP). The address for the WTP is 4500 North Dort Highway, Flint, Michigan 48505.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required for the Chemical System Feed Building Project as shown on the drawings and specified herein.

B. The work shall include but is not necessarily limited to the following:
   1. Obtain necessary permits and variances (i.e. Dewatering Water Disposal Variance, Building Permit and Soil Erosion and Sediment Control Permit)
   2. Coordinate with other on-site contractors associated with installation of new GLWA flow meter, 2-6” water supply connections and piping modifications, new GCDC 36” pipeline, flow meter, vault and three (3) chemical injection quills and 36” pipeline connector.
   3. Install soil erosion and sediment control system around construction site at the Flint WTP.
   4. Clear trees, sod and existing road and locate underground utilities.
   5. Construct new Chemical Systems Feed building including excavation concrete foundation, masonry walls, hollow core structural ceiling/roof and water tight membrane roof.
   6. Install bulk and day tanks and chemical transfer and feed pumps and associated equipment and piping for three water treatment chemicals 1) Sodium Hypochlorite 2) Sodium Hydroxide (i.e. caustic soda) and 3) Ortho Phosphoric Acid (i.e. corrosion inhibitor) as shown on the drawings and specified herein.
   7. Install building HVAC, plumbing systems including roof air handling unit and electrical unit heaters and hot water tank, slop sink, sump pumps, etc.
   8. Install building electrical and instrumentation and controls.
   9. Installation of a new transformer, switchboard and motor control centers, low voltage wire and conduit, panelboards, disconnects, lighting etc. and miscellaneous and appurtenant items as shown on the drawings and specified herein.
   10. Performance test all new equipment, instrumentation and controls, and other systems as specified herein.
   11. Install new yard piping, bends, elbows, tees, crosses, fittings, valves, pipe support systems, etc.as shown on the drawings and specified herein. Including underground chemical carrier tubing and PVC casing pipe, ductile iron water supply pipe and copper chemical sample pipe and manhole.
   12. Install underground concrete encased electrical and I&C duct bank as shown on the drawings and specified herein.
   13. Installation manhole, copper sampling pipe and sampling equipment, etc.
   14. Install new concrete pavement system.
   15. Perform all sitework as required to complete the project.
   16. Provide O&M equipment manuals, equipment training and start-up services.

C. Existing conditions shown are approximate. The Contractor is responsible for field verifying existing conditions prior to construction, including any underground utilities that may interfere with the proposed work.

1.3 CONTRACTOR'S USE OF PREMISES

A. Contractor shall limit the use of the premises for his/her Work and for storage to allow for:
   1. Work by other contractors.
   2. Owner occupancy.

B. Coordinate use of premises with the Owner and/or Engineer.

C. Contractor shall assume full responsibility for security of all his/her and his/her subcontractors' materials and equipment stored on the site.

D. If directed by the Owner and/or Engineer, move any stored items which interfere with operations of Owner or other contractors.

E. Obtain and pay for use of additional storage or work areas if needed to perform the Work.

F. Refer to Security Procedures section for normal Working Hours.

G. Noise on the construction site shall be limited to comply with City ordinance where the project is located.

1.4 RELATED WORK NOT INCLUDED

A. Construction Sequence/Coordination is included in Section 011400.

B. Security Procedures are included in Section 013553.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PERMITS AND VARIANCES

A. Dewatering Water Disposal Variance

It is expected that groundwater and surface water runoff in connection with the excavations for the building, underground piping, conduit, etc. will need to be controlled to maintain a dry excavation as specified and allow work to progress. It is the intent for this water to be disposed of into the City of Flint's sanitary sewer system. Sanitary sewer manholes that can be used to discharge water are located within 750 feet of the excavations and trenches. Refer to the Report on Geotechnical Investigation - New Chemical Systems Feed Building City of Flint Water Treatment Plant Flint Michigan by Somat Engineering, Inc. for anticipated water volumes and other related information.

The City of Flint requires that a discharge variance application be submitted, and a permit issued before water can be discharged into the sanitary sewer. The variance application entitled "Request for Water Discharge Variance Fact Sheet" and Flint's POTW regulations entitled "Discharge Prohibitions and Limits (with Definitions)" are included herewith for the Contractors use. The Contractor will be required to sample water intended to be discharged into the sewer and include those analytical results with the application. For questions regarding the application and variance process, please call Tom Hutchings at the City of Flint at (810) 766-7210 (ext. 3655). No permit fee is required.

B. Building Permit

The City of Flint requires that a building permit be obtained from the Flint Department of Planning and Development – Business Services and Permitting – Inspection Division. An Application for Building Permit can be obtained from the City of Flint website. For questions regarding the application and permitting process, please call Mike Reiter at the City of Flint at (810) 766-7284. A sample application is attached for reference. The Inspection Division will determine the permit fee. An allowance is provided in the bid form to cover the cost of the permit fee.

C. Soil Erosion can Sediment Control Permit

It is expected that a Soil Erosion and Sediment Control permit will not be needed from Genesee County, Michigan as the limits of construction are more than 500 feet away from receiving waters. However, the area disturbed by construction may exceed one (1) acre so the need for a permit must be confirmed. As a conservative measure, the Contract Documents provide soil erosion and sediment control provisions.

END OF SECTION 011000

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SECTION 011400 – CONSTRUCTION SEQUENCE / COORDINATION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. In general, no Work which affects or could affect plant and water distribution system operations or plant and water distribution system performance shall be performed without a specific detailed plan by the Contractor without review and approval in advance by the Engineer and the Owner. All requests for plant and water distribution system diversions, shutdowns, modifications, etc. shall be in writing to the Owner with a copy to the Engineer.

B. The construction progress schedule required under Section 01 32 16 – Construction Scheduling shall reflect, at a minimum, the conditions presented in this section and do not preclude the Contractor's responsibility to coordinate the Work and maintain continuous plant and water distribution system operations at all times.

C. All required shutdowns shall be identified in the Contractor's initial schedule provided under Section 01 32 16 – Construction Scheduling.

1.2 DEFINITIONS AND TERMS

A. Plant and Water Distribution System Operational Constraints – The constraints to performance of the Work required because of plant and water distribution system operations which must be maintained at all times are identified in this section. These constraints shall be included in the Contractor's progress schedule.

B. Construction Scheduling Constraints – The constraints to performance of the Work required because of special sequencing with other parts of the Work, calendar time constraints and special testing, commissioning and work procedures are identified in this Section. These constraints are in addition to the standard procedural constraints such as shop drawings, testing, commissioning, training, etc. and the above plant operational constraints. These constraints shall be included in the Contractor's progress schedule.

C. Special Conditions – Certain special conditions, if any, related to performance of the Work are identified in this section. If they affect the scheduling of the Work, they shall be included in the Contractor's progress schedule.

D. Contractor – Refers to the contractor performing work on this contract.

1.3 INTERFACE/COOPERATION WITH SECONDARY WATER SUPPLY CONTRACTOR

A. The Contractor will be required to closely coordinate with other on-site contractors working in close proximity to this project. Construction work by others includes:
   1. GCDC's 36-inch water pipeline.
   2. GCDC's 36-inch connector pipe to connect the existing 36-inch and 48-inch pipelines.

3. Replacement of the existing GLWA flow meters and two (2) - 6" water supply connections in Control Station #2 and associated piping modification inside and outside of the CS#2.
4. Soft dig effort (hydro-vac) to confirm location of existing underground utilities

It is the goal of the Secondary Water Supply contractor to have the underground concrete vault, three (3) chemical injection quills and two (2) - 6" water supply connections in Control Station #2 completed by August 1, 2020.

Other required coordination includes:

5. communication and control signals from replacement GLWA flow meters and new GCDC flow meter for use in programming the chemical metering pumps
6. Electrical supply and communication signal duct bank for both new Chemical Systems Feed Building and Secondary Water Supply vault.
7. Installation and connection of chemical injection hoses in the GCDC Metering vault. Three (3) total.

1.4 SITE USAGE CONSTRAINTS

A. When pedestrian or vehicle access through construction areas must be disrupted, coordinate with the Owner, and provide alternate acceptable access for the plant operators or other contractors.

B. All primary site access for the Contractor and its Subcontractors shall be from the Main Gate at Dort Highway. The West Boulevard Drive entrance immediately adjacent to the construction site as shown on the Drawings may be used for deliveries only when permitted by Owner. During all deliveries, the Contractor shall have a badged employee staged at the security gate to escort the delivery on the site.

C. The work performed by the Contractor shall not impede or hinder chemical deliveries to the Garage adjacent to Control Station No. 2 and/or access to Control Station No. 2, Electrical Substation and the Warehouse. Should deliveries be impeded, the Contractor shall be responsible for providing a temporary means for delivering chemicals to the existing systems.

D. Coordinate the activities in the interface or common areas with other contractors and the plant operators. Submit to the Engineer a description and schedule as to how the common areas will be used, recognizing the required coordination with other contractors and the Owner, safety, and ease of use.

E. The Owner's facilities, including but not limited to Garage, Control Station No.2, Electrical Substation, Warehouse, restrooms, offices, and parking lots shall not be used by the Contractor or its Subcontractors.

F. Contractor employee access to the Owner's facilities shall be defined by the Owner prior to the start of construction. The Contractor shall not access any areas or facilities without the prior consent of the Owner. Contractor parking and construction trailers shall be located within a designated staging area as indicated on the drawings and approved by the Owner.

G. The Contractor and Subcontractor's shall be subject to and comply with all of the Owner's security procedures, including, but not limited to: restricted access to the water treatment plant site, and limited access to existing water treatment plant facilities. Security measures may vary over the course of the project and the Contractor and Subcontractor's shall comply with all reasonable procedure modifications such as badging, responsible person assignments and employee identification.

H. Safe access shall be provided for the Owner's operations and maintenance groups at all times.

I. Locations of staging areas and construction trailers shall be coordinated with and approved by the Owner and Engineer.

1.5 PROCESS CONSTRAINTS

A. The new two (2) - 6" water supply connections, GCDC 36" pipeline connection vault and three (3) chemical injection connections will need to be installed by the Other Contractor before the Contractor can complete the contract work.

1.6 PRODUCTION CONSTRAINTS

A. The 48" water main water must be capable of suppling 15 mgd of water to the Flint distribution system during the construction period at all times and meet its water quality permit requirements under all operating conditions.

1.7 CONSTRUCTION CONSTRAINTS

A. The Contractor shall be aware that work on this project shall be continuous. Periods of intermittent work are not permitted on this project. Shop drawing submittals are not included in this requirement.

B. The Contractor shall notify the Owner at least 14 calendar days in advance of any shutdown. Only the Owner's operations personnel are allowed to execute the necessary procedures to isolate and remove units from service.

C. During construction, 48" water distribution main and Plant shutdowns are not expected to be needed to complete the work.

D. The Owner reserves the right to cancel any scheduled activities or shutdowns without prior notice to the Contractor, in order to preserve operational capability of the water mains and plant.

E. If it is required that the Owner operate a valve, gate, stop log or similar item for isolation of a unit from service or to provide the Contractor with shutoff service, and if shutoff is not achieved, the Owner shall be afforded seven (7) calendar days to make repairs necessary to provide shutoff service. Drip tight closure of valves, gates, and stop logs is not guaranteed to the Contractor. Minor leakage past existing gates and valves, is considered normal and it is the responsibility of the Contractor to manage and dispose of such leakage.

F. During demolition work, the Owner's personnel shall have access to all areas of the site at any time during construction. The Contractor shall stage and sequence the demolition so as not to

hinder access, or hinder operations/maintenance procedures performed by the Owner's personnel.

G. The Owner will coordinate maintenance tasks with the Contractor so as to minimize impacts on construction activities.

H. The Contractor shall be aware that it may be necessary to schedule and execute work outside of normal working hours. This work shall be coordinated with the Owner through the Engineer.

1.8 CONSTRUCTION SEQUENCING

A. A general sequence of construction is listed below.
   1. Obtain necessary permits and variances (i.e. Dewatering Water Disposal Variance, Building Permit and Soil Erosion and Sediment Control Permit)
   2. Coordinate with other on-site contractors associated with installation of new GLWA flow meter, 2-6" water supply connections and piping modifications, new GCDC 36" pipeline, flow meter, vault and three (3) chemical injection quills and 36" pipeline connector.
   3. Install soil erosion and sediment control system around construction site at the Flint WTP.
   4. Clear trees, sod and existing road and locate underground utilities.
   5. Construct new Chemical Systems Feed building including:
      a. excavation, structural fill, concrete foundation, masonry walls, hollow core structural ceiling/roof and water tight membrane roof, doors, etc. as shown on the drawings and specified herein
      b. building HVAC, plumbing systems including roof air handling unit and electrical unit heaters and hot water tank, slop sink, sump pumps, etc.
      c. building electrical and instrumentation and controls
      d. building fire suppression system
      e. new transformer, switchboard and motor control centers, low voltage wire and conduit, panelboards, disconnects, lighting etc. and miscellaneous and appurtenant items as shown on the drawings and specified herein.
      f. bulk and day tanks and chemical transfer and feed pumps and associated equipment and piping for three water treatment chemicals 1) Sodium Hypochlorite 2) Sodium Hydroxide (i.e. caustic soda) and 3) Ortho Phosphoric Acid (i.e. corrosion inhibitor) as shown on the drawings and specified herein.
   6. Construct new yard piping, bends, elbows, tees, crosses, fittings, valves, pipe support systems, etc.as shown on the drawings and specified herein. Including underground chemical carrier tubing and PVC casing pipe, ductile iron water supply pipe and copper chemical sample pipe and manhole.
   7. Construct underground concrete encased electrical and I&C duct bank as shown on the drawings and specified herein.
   8. Construct manhole, copper sampling pipe and sampling equipment, chemical analyzers etc. Complete all Tank Control House modifications.
   9. Construction new concrete pavement system.
   10. Complete all sitework as required to complete the project.
   11. Test all new equipment, instrumentation and controls, and other systems as specified herein.
   12. Provide O&M equipment manuals, equipment training and start-up services.

B. Substantial completion of the entire work shall be accomplished by December 31, 2019. The warranty period will begin on the date of overall substantial completion.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 011400

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SECTION 012000 – APPLICATION FOR PAYMENT

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to the Engineer in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

B. The accepted Schedule of Values, Section 013592, shall be used as the basis for the Contractor's Application for Payment.

1.2 RELATED WORK

A. Agreement between Owner and Contractor is included in Section 005200 – Standard Form of Agreement.

B. Standard General Conditions of the Construction Contract are included in Section 007213 – General Conditions.

C. Supplementary Conditions are included in Section 007300 – Supplementary Conditions.

D. Construction schedules are included in Section 013300 – Construction Scheduling.

E. Schedule of Values are included in Section 013592 – Schedule of Values.

F. Construction Photographs are included in Section 013593 – Construction Photographs and Video Documentation.

G. Contract Closeout is included in Section 017700 – Contract Closeout.

1.3 SUBMITTALS

A. Submit, in accordance with Section 013300 – Submittal Procedures, applications typed on forms provided by the Owner, Application for Payment, with itemized data typed on 8-½-in by 11-in white paper continuation sheets. Note that payment may be delayed at the Owner’s discretion if all required items are not submitted with each pay application.

B. Provide itemized data on continuation sheet.
   1. Format, schedules, line items and values: Those of the Schedule of Values accepted by the Engineer.

C. Provide construction photographs in accordance with Section 013593 – Construction Photographs and Video Documentation.

D. Provide an updated construction schedule per Section 013216 – Construction Scheduling.

1.4 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

A. Application Form
   1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.
   2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.
   3. Percent complete on any line item shall not exceed 80 percent until after required preliminary O&M Manuals have been submitted.
   4. Percent complete on any line items shall not exceed 90 percent until after required final O&M Manuals have been accepted, including asset management data and spare parts registry.
   5. Execute certification with signature of a responsible officer of Contract firm.
   6. Applications for payment shall be submitted on EJCDC Document C-620.

B. Continuation Sheets
   1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.
   2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.
      a. Round off values to nearest dollar, or as specified for Schedule of Values.
   3. List each Change Order executed prior to date of submission, at the end of the continuation sheets.
      a. List by Change Order Number and description, as for an original component item of work.
   4. To receive approval for payment on component material stored on site, submit copies of the original paid invoices with the application for payment.

1.5 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, submit suitable information, with a cover letter identifying.
   1. Project.
   2. Application number and date.
   3. Detailed list of enclosures.
   4. For stored products:
      a. Item number and identification as shown on application
      b. Description of specific material.

B. Submit one copy of data and cover letter for each copy of application.

C. As a prerequisite for payment, submit a "Surety Acknowledgement of Payment Request" letter showing amount of progress payment which the Contractor is requesting.

D. Maintain an updated set of drawings to be used as record drawings in accordance with Section 017839. As a prerequisite for monthly progress payments, exhibit the updated record drawings for review by the Owner and the Engineer.

1.6 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in Application form as specified for progress payments.

B. Use continuation sheet for presenting the final statement of accounting as specified in Section 017700 – Closeout Procedures.

C. Submit all Project Record Documents in accordance with Section 017839 – Project Record Documents.

1.7 SUBMITTAL PROCEDURES

A. Submit Applications for Payment to the Engineer at the times stipulated in the Agreement.

B. Number: Three copies of each Application.

C. When the Engineer finds Application properly completed and correct, he/she will transmit certificate for payment to Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012000

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SECTION 012213 – MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 GENERAL

A. This Section defines the Work to be included in each Bid Item of the Proposal (Bid Schedule) of these Contract Documents. Payment will be made based on the specified items included in the description for each Bid Item.

B. All Work under this Contract shall be complete, in-place, fully tested, ready for continuous uninterrupted service and Final Acceptance by the Owner. Required items of Work and incidentals necessary for the satisfactory completion of the Work which are not specifically listed in the Bid Schedule, and which are not specified in this Section to be measured or included in one of the items listed in the Bid Schedule, shall be considered as incidental to the Work.

C. All costs including all such items as freight, taxes, and overhead and profit, shall be included in the lump sum or unit prices bid for the various Bid Items unless specifically noted otherwise. All Contract prices included within the Bid Schedule will be full compensation for all labor, materials, tools, equipment, overhead and incidentals necessary to complete the Work as shown on the Contract Drawings and/or as specified in the Contract Documents unless specifically noted otherwise.

D. Measurement of an item of Work shall be by the units indicated within the Bid Schedule.

E. Payment for all Bid Items listed in the Bid Schedule shall constitute full compensation for all Work shown and/or specified to be performed under each Bid Item and shall include all necessary and incidental Work not specified to be included in any other Bid Item listed in the Bid Schedule.

F. Payment for materials and equipment that are not yet incorporated into the Work but delivered and suitably stored at the Site or at another location agreed to in writing shall be processed when procedures identified in Section 14.02.A.1 of Section 00 72 13 – General Conditions are followed.

PART 2 - PRODUCTS AND MATERIALS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAY ITEMS

A. Item 1 – Lump Sum

1. Measurement for Item 1 is the cost for furnishing all labor, materials, equipment and incidentals required to complete the Chemical Systems Feed Building Contract per the Drawing and Specifications except as provided for separately in the Items below.
2. The Contractor will not be paid for any additional costs associated with the bid item beyond the lump sum value in the Bid Forms.

B. Item 2 – Owners' New Utility Allowance
1. Measurement for Item 2 is an Owner controlled allowance to pay for the Utility to extend the natural gas service to the new Chemical Systems Feed building up to and including the meter.
2. The Contractor will be responsible for working with and coordinating the installation and include all associated costs for this effort in Item 1 - Lump Sum cost.
3. The Contractor will not be paid for any additional costs associated with the bid item beyond the lump sum value in the Bid Forms.

C. Item 3 – Owner's General Allowance
1. Measurement for Item 3 is an Owner controlled allowance to use as required to accomplish project objectives.
2. The Contractor will be responsible for coordinating with the Owner to accomplish these objectives and will be compensated through the Change Order process as described in the Contract should additional work be required.

D. Item 4 – Excavation and Disposal of Unsuitable Material Beneath Building Foundation and/or Slab Subbase.
1. Measurement for Item 4 is the cost of the Contractor to removal and dispose of unsuitable native material (i.e. subgrade) located beneath the building foundation and floor slab subbase. Cost to remove and dispose of native material above this elevation shall be included in the lump sum cost. Removal quantities below deepest Geogrid material will be based on in-place (in-situ) cubic yards confirmed through survey, standard measurement or as agreed to by the Engineer and Contractor.
2. The Engineer or independent geotechnical laboratory will determine limits of removal via proof rolling, bearing pressure measurement and/or visual observation. Disposal will be per Contract requirements.

E. Item 5 – Furnish and Install Structural Fill (MDOT 21AA per Section 1 through 6 on Sheet S-3) Beneath Building Foundation and/or Slab Subbase.
1. Measurement for Item 5 is the cost by the Contractor for furnishing all labor, materials, equipment and incidentals required to install per in-place (in-situ) cubic yard of structural fill and replace unsuitable native material (i.e. subgrade) located beneath the building foundation and floor slab subbase. Installed quantities can be confirmed through survey, standard measurement or as agreed to by the Engineer and Contractor.
2. Installation of the new material will be per Section 312000 – Earthwork and confirmed by the Engineer or independent geotechnical laboratory.

F. Item 6 – Excavation and Disposal of Unsuitable Material Beneath Pavement Subbase.
1. Measurement for Item 6 is the cost of the Contractor to removal and dispose of unsuitable native material (i.e. subgrade) located beneath pavement subbase. Cost to remove and dispose of native material above this elevation shall be included in the lump sum cost. Removal quantities below the subbase will be based on in-place (in-situ) cubic yards confirmed through survey, standard measurement or as agreed to by the Engineer and Contractor.

2. The Engineer or independent geotechnical laboratory will determine limits of removal via proof rolling, bearing pressure measurement and/or visual observation. Disposal will be per Contract requirements.

G. Item 7 – Furnish and Install Structural Fill (1" x 3" Stone Backfill per Details F through H on Sheet C-9) Beneath Pavement Subbase.
   1. Measurement for Item 7 is the cost by the Contractor for furnishing all labor, materials, equipment and incidentals required to install per in-place (in-situ) cubic yard of structural fill and replace unsuitable native material (i.e. subgrade) located beneath the building foundation and floor slab subbase. Installed quantities can be confirmed through survey, standard measurement or as agreed to by the Engineer and Contractor.
   2. Installation of the new material will be per Section 312000 – Earthwork and confirmed by the Engineer or independent geotechnical laboratory.

H. Item 8 – Clean 8-inch Sanitary Sewer
   1. Measurement for Item 8 is the lump sum cost for furnishing all labor, materials, equipment and incidentals required for cleaning the existing 8-inch sanitary sewer.
   2. The Contractor shall be paid for actual linear footage cleaned as measured by the Contractor and verified by the Resident Project Representative.

I. Item 9 – Televise 8-inch Sanitary Sewer
   1. Measurement for Item 9 is the lump sum cost for furnishing all labor, materials, equipment and incidentals required for cleaning the existing 8-inch sanitary sewer.
   2. The Contractor shall be paid for actual linear footage televised as measured by the Contractor and verified by the Resident Project Representative.

END OF SECTION 012213

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SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Substitutions shall conform to SPECIFICATION 007213 – General Conditions, Paragraph 6.05.

1.2 RELATED WORK

A. Substitutions during the Bidding Period are included in Section 00 21 13 – Instructions to Bidders.

B. Bid Form is included in Section 00 41 00 – Bid Form.

1.3 SUBMITTAL OF LIST OF PROPOSED SUBSTITUTIONS

A. Bidders shall submit their list of proposed substitutions and the proposed monetary changes associated therewith to the Owner on the standard form provided together with their bids.

1.4 CONTRACTOR'S OPTIONS

A. For Products specified only by reference standard, select product meeting that standard, by any manufacturer.

B. For Products specified by naming several products or manufacturers, select any one of products and manufacturers named which complies with Specifications.

C. For products specified by naming one or more products or manufacturers and stating "or equal," submit a request as for substitutions, for any product or manufacturer which is not specifically named.

D. For products specified by naming a specific product and manufacturer, there is no option and no substitution will be allowed.

1.5 SUBSTITUTIONS

A. In order for substitutions to be considered, the Contractor shall submit, within 30 days of issuance of Notice of Award, complete data as set forth herein to permit complete analysis of all proposed substitutions noted on his substitutions list submitted with the bid form. No substitution shall be considered unless the Contractor provides the required data in accordance with the requirements of this Section within the 30-day period.

B. Submit separate request for each substitution. Support each request with:

1. Complete data substantiating compliance of proposed substitution with requirements stated in Contract Documents:
    a. Product identification, including manufacturer's name and address.
    b. Manufacturer's literature; identify:
        1) Product description.
        2) Reference standards.
        3) Performance and test data.
        4) Operation and maintenance data.
    c. Samples, as applicable.
    d. Name and address of similar projects on which product has been used, and date of each installation.
2. Itemized comparison of the proposed substitution with product specified; List significant variations. Substitution shall not change design intent and shall perform equal to that specified.
3. Data relating to impact on construction schedule occasioned by the proposed substitution.
4. Any effect of substitution on separate contracts.
5. List of changes required in other work or products.
6. Accurate cost data comparing proposed substitution with product specified.
    a. Amount of any net change to Contract Sum.
7. Designation of required license fees or royalties.
8. Designation of availability of maintenance services, sources of replacement materials.

C. Substitutions will not be considered for acceptance when:
1. They are indicated or implied on shop drawings or product data submittals without a formal request from Contractor.
2. They are requested directly by a subcontractor or supplier.
3. Acceptance will require substantial revision of Contract Documents.

D. Requests for substitutions submitted after Notice of Award will not be considered unless evidence is submitted to the Engineer that all of the following circumstances exist:
1. The specified product is unavailable for reasons beyond the control of the Contractor. Such reasons shall consist of strikes, bankruptcy, discontinuance of manufacturer, or acts of God.
2. The Contractor placed, or attempted to place, orders for the specified products within 10 days after Notice of Award.
3. Request for substitution is made in writing to the Engineer within 10 days of the date on which the Contractor ascertains that he cannot obtain the item specified.
4. Complete data as set forth herein to permit complete analysis of the proposed substitution is submitted with the request.

E. The Engineer's decision regarding evaluation of substitutions shall be considered final and binding. Requests for time extensions and additional costs based on submission of, acceptance of, or rejection of substitutions will not be allowed. All approved substitutions will be incorporated into the Agreement by Change Order.

1.6 CONTRACTOR’S REPRESENTATION

A. In making formal request for substitution, Contractor represents that:
1. He has investigated proposed product and has determined that it is equal to or superior in all respects to that specified.

2. He will provide same warranties or bonds for substitution as for product specified.
3. He will coordinate installation of accepted substitution into the Work and will make such changes as may be required for the Work to be complete in all respects.
4. He waives claims for additional costs caused by substitution which may subsequently become apparent.
5. Cost data is complete and includes related costs under his Contract, but not:
    a. Costs under separate contracts.
    b. Engineer's costs for redesign or revision of Contract Documents.

1.7 ENGINEER DUTIES

A. Review Contractor's requests for substitutions with reasonable promptness.

B. Notify Contractor, in writing, of decision to accept or reject requested substitution.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012500

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SECTION 012900 – CHANGE ORDER PROCEDURES

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Promptly implement change order procedures.
   1. Provide full written data required to evaluate changes.
   2. Maintain detailed records of work done on a time-and-material/ force account basis.
   3. Provide full documentation to Engineer on request.

B. Designate in writing the member of Contractor’s organization:
   1. Who is authorized to accept changes in the Work.
   2. Who is responsible for informing others in the Contractor's employ of the authorization of changes in the Work.

C. Owner will designate in writing the person who is authorized to execute Change Orders.

1.2 RELATED REQUIREMENTS

A. Conditions of the Contract are included in Section 007213.
   1. Methods of determining cost or credit to Owner resulting from changes in work made on a time and material basis.
   2. Contractor's claims for additional costs.

B. Applications for Payment are included in Section 012000.

C. Schedule of Values are included in Section 013592.

D. Project Record Documents are included in Section 017839.

1.3 DEFINITIONS

A. Change Order: See Contract for Construction.

B. Construction Change Authorization: A written order to the Contractor, signed by Owner and Engineer, which amends the Contract Documents as described and authorized Contractor to proceed with a change which affects the Contract Sum or the Contract Time, for inclusion in a subsequent Change Order.

C. Field Order: A written order to the Contractor signed by the Engineer and the Contractor, which is issued to interpret/clarify the Contract Documents, order minor changes in the work and/or memorialize trade-off agreements. The work described by a Field Order is to be accomplished without change to the Contract Sum, Contract Time, and/or claims for other costs.

1.4 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor. Request will include:
   1. Detailed description of the Change, Products and location of the change in the project.
   2. Supplementary or revised Drawings and Specifications.
   3. The projected time span for making the change and a specific statement as to whether overtime work is, or is not, authorized.
   4. A specific period of time during which the requested price will be considered valid.
   5. Such request is for information only and is not an instruction to execute the changes, nor to stop work in progress.

B. Contractor may initiate changes by submitting a written notice to Engineer, containing:
   1. Description of the proposed changes.
   2. Statement of the reason for making the changes.
   3. Statement of the effect on the Contract Sum and the Contract Time.
   4. Statement of the effect on the work of separate contractors.
   5. Documentation supporting any change in Contract Sum or Contract Time, as appropriate.

1.5 WORK DIRECTIVE CHANGE AUTHORIZATIO

A. In lieu of a Request for Proposal (RFP), Engineer may issue a work directive authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate the method of determining any change in the Contract Sum and any change in Contract Time.

C. Owner and Engineer will sign and date the Work Directive Change Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor may sign and date the Construction Change Authorization to indicate agreement with the terms therein.

1.6 DOCUMENTATION OF PROPOSALS AND CLAIMS

A. Support each quotation for a lump-sum proposal and for each unit price which has not previously been established, with sufficient substantiating data to allow Engineer to evaluate the quotation.

B. On request, provide additional data to support time and cost computations.
   1. Labor required.
   2. Equipment required.
   3. Products required.
      a. Recommended source of purchase and unit cost.
      b. Quantities required.
   4. Taxes, insurance and bonds.
   5. Credit for work deleted from Contract, similarly documented.
   6. Overhead and profit.

7. Justification for any change in Contract Time.

C. Support each claim for additional costs and for work done on a time-and-material/force account basis, with documentation as required for a lump-sum proposal, plus additional information.
1. Name of the Owner's authorized agent who ordered the work and date of the order.
2. Dates and times work was performed and by whom.
3. Time record, summary of hours worked and hourly rates paid.
4. Receipts and invoices for:
   a. Equipment used, listing dates and times of use.
   b. Products used, listing of quantities.
   c. Subcontracts.

1.7 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Order will describe changes in the work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.

C. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

D. Field Order will describe interpretations or clarifications of Contract Documents, order minor changes in the work, and/or memorialize trade-off agreements.

E. Field Order work will be accomplished without change in the Contract Sum, Contract Time, and/or claims for other costs.

1.8 LUMP-SUM / FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
1. Engineer's Proposal Request and Contractor's responsive Proposal as mutually agreed between Owner and Contractor.
2. Contractor's Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms therein.

1.9 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
1. Engineer's definition of the scope of the required changes.
2. Contractor's Proposal for a change, as recommended by Engineer.
3. Survey of completed work.

B. The amounts of the unit prices to be:
1. Those stated in the Agreement.

2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the Work:
1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
2. Contractor will sign and date the Change Order to indicate agreement with the terms therein.

D. When quantities of the items cannot be determined prior to start of the Work:
1. Engineer or Owner will issue a construction change authorization directing Contractor to proceed with the change on the basis of unit prices and will cite the applicable unit prices.
2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
a. Contractor shall submit documentation, including timesheets for labor, to establish the number of units of each item and any claims for a change in Contract Time.
3. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.
4. Owner and Contractor will sign and date the Change Order to indicate their agreement with the terms therein.

1.10 TIME AND MATERIAL / FORCE ACCOUNT CHANGE ORDER / WORK DIRECTIVE CHANGE AUTHORIZATION

A. Engineer and Owner will issue a Work Directive Change Authorization directing Contractor to proceed with the changes.

B. At completion of the change, submit itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section.

C. Engineer will determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions.

D. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

E. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Request for Payment forms to record each change as a separate item of work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time.
1. Revise sub-schedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 012900

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SECTION 013000 – REQUESTS FOR INFORMATION

PART 1 - GENERAL

1.1 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of Requests for Information (RFIs).

1.2 RELATED WORK

A. Additional requirements may be specified in the General Conditions.

B. Submittals are included in Section 013300.

C. Project Record Documents are included in Section 017839.

1.3 REQUESTS FOR INFORMATION

A. When the Contractor believes that additional information or clarification of a contract requirement is needed, it may initiate a Request for Information.

B. RFIs may relate to Technical matters or Administrative matters. The RFI process shall be limited to the clarification of technical and/or administrative matters. While the response to an RFI might lead to a change in the contract scope, cost or time, RFIs are not a substitute to the notification requirements stipulated in the General Conditions.

C. A response to an RFI may authorize minor changes to the contract consistent with the terms of the Contract related to the responsibilities and limitations of authority of the Engineer.

D. A response to an RFI is not an authorization to perform any additional work that would require that change order or written amendment to the contract. If the Contractor believes the response to an RFI requires a change to the contract, Contractor shall promptly provide written notice to the Owner and Engineer in accordance with the General Conditions.

E. RFIs are not a substitute for the Submittals process specified elsewhere.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 ORIGINATION

A. The Contactor shall originate RFIs using a form mutually agreed upon with the Owner and Engineer.
   1. RFIs shall be numbered consecutively. In the event that an answered RFI results in a follow-up inquiry, the follow-up shall maintain the same number as the original, appended with a suffix.
   2. Include Specification Section(s), Drawing(s), or detail(s) for which information is requested.
   3. Attach drawings, sketches, photographs or other relevant information.
   4. If the question concerns an interpretation of the Contract Documents, enter the Contractor's interpretation.
   5. Indicate the date by which the Contractor requests a reply.
   6. Sign the upper portion of the form.

B. RFIs may not be submitted by subcontractors or suppliers. When a subcontractor or supplier generates a request for information or clarification to the Contractor, Contractor shall incorporate such requests into the required format, assign the next number, and sign.

C. Contractor shall maintain a log of all RFIs including the date originated, date delivered, and date answered.

3.2 PROCESSING

A. Contractor shall submit all RFIs to the Engineer for processing.

B. Technical RFIs will generally be reviewed and answered by the respective discipline engineer or architect.

C. Administrative RFIs will generally be reviewed and answered by the Engineer in consultation with the Owner.

D. The Engineer will generally respond to RFIs within three calendar days of receipt – depending on the complexity of the inquiry.

3.3 RESPONSES

A. If the RFI contains sufficient clarity, the Engineer will insert a response in the lower portion of the RFI form, sign and date the response, and return the completed form to the Contractor.

B. If the RFI does not contain sufficient clarity, the Engineer may request additional information from the Contractor.

C. Engineer will distribute copies to the Owner and project files.

D. Engineer will maintain a log of all RFIs including the date received and date returned to Contractor.

3.4 RECORD INFORMATION

A. Contractor shall include all clarifications obtained through the RFI process into the record information in accordance with Section 017839.

END OF SECTION 013000

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SECTION 013113 – PROJECT COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor shall act as the project coordinator, be responsible for conditions of the contract, administrative requirements, Subcontractor's scheduling and cooperation, compliance with specifications and drawings, and all other work related requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COORDINATION OF WORK WITH CONTRACTORS / SUBCONTRACTORS

A. Coordinate the work with adjacent work and cooperate with other Contractors so as to facilitate the general progress of the work. Each Contractor shall afford all other Contractors reasonable opportunity for the installation of their work and for storage of their materials. In no case will any Contractors be permitted to exclude from the premises or work, any other Contractors or employees thereof, or interfere with any Contractors in the executing or installation of the work.

B. Each Contractor shall perform work in proper sequence in relation to that of other Contractor and as approved by the Owner. Any cost caused by defective or ill-timed work shall be borne by the Contractor responsible thereof.

C. Arrange the work and dispose of materials so as not to interfere with the work or shortage of materials of others and so that each Contractor joins their work to that of others in accordance with the intent of the Contract Documents.

D. All Contractors shall work in cooperation with each other and fit their work into the structure as job conditions may demand. All final decisions, such as rights-of-way, shall be made by the Owner or Engineer.

3.2 COORDINATION OF WORK WITH OWNER AND FIELD REPRESENTATIVE

A. Coordinate work with routine activities of the Owner to maintain plant operations.

B. Maintaining conveyance of water to the Flint distribution system is of paramount importance. The Owner reserves the right to declare emergency conditions. At the Owner's discretion, all construction work can be halted until the emergency condition is resolved.

3.3 WORK PROGRESS

A. Keep constant check on the progress of work. Periodically make inspections of work in progress and notify the Owner when work is complete and in compliance with the Contract Documents.

3.4 COORDINATION WITH OTHER ON-SITE CONTRACTORS

A. The Contractor will be required to closely coordinate with other on-site contractors working in close proximity to this project. Construction work by others includes:
   1. GCDC's 36-inch water pipeline.
   2. GCDC's 36-inch connector pipe to connect the existing 36-inch and 48-inch pipelines.
   3. Replacement of the existing GLWA flow meters and two (2) - 6" water supply connections in Control Station #2 and associated piping modification inside and outside of the CS#2.
   4. Soft dig effort (hydro-vac) to confirm location of existing underground utilities

   It is the goal of the Secondary Water Supply contractor to have the underground concrete vault, three (3) chemical injection quills and two (2) - 6" water supply connections in Control Station #2 completed by August 1, 2020.

   Other required coordination includes:
   5. communication and control signals from replacement GLWA flow meters and new GCDC flow meter for use in programming the chemical metering pumps
   6. Electrical supply and communication signal duct bank for both new Chemical Systems Feed Building and Secondary Water Supply vault.
   7. Installation and connection of chemical injection hoses in the GCDC Metering vault. Three (3) total.

B. Contractor shall participate in coordination meetings, identified as a specially called meeting in Section 01 31 19 – Project Meetings.

C. Contractor shall coordinate and construct piping as shown on the drawings to interface with the Secondary Water Supply contract.

END OF SECTION 013113

SECTION 013119 – PROJECT MEETINGS

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. The Engineer shall schedule and administer a pre-construction meeting, periodic progress meetings and specially called meetings throughout progress of the work.
   1. Prepare agenda for meetings.
   2. Make physical arrangements for meetings.
   3. Preside at meetings.
   4. Record the minutes; include significant proceedings and decisions.
   5. Reproduce and distribute copies of minutes within 15 working days after each meeting.
      a. To participants in the meeting.
      b. To parties affected by decisions made at the meeting.

B. Representatives of Contractors, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. Attend meetings to ascertain that work is expedited consistent with Contract Documents and construction schedules.

1.2 RELATED REQUIREMENTS

A. Project Coordination is included in Section 013113.

B. Construction Schedules are included in Section 013216.

C. Shop Drawings, Working Drawings and Samples are included in Section 013300.

D. Project Record Documents are included in Section 017839.

E. Operating and Maintenance Data is included in Section 017823.

1.3 PRE-CONSTRUCTION MEETING

A. Schedule a preconstruction meeting no later than 15 days after date of Notice to Proceed.

B. Location: Flint Water Treatment Plant

C. Attendance:
   a. Owner's Representative.
   b. Engineer and his/her professional consultants.
   c. Resident Project Representative.
   d. Contractor's Superintendent.
   e. Major Subcontractors.
   f. Major suppliers.

g. Utilities.
h. Others as appropriate.

D. Suggested Agenda
1. Sign-in and Introductions
   a. Designation of responsible personnel
2. Contract Documents status
   a. Agreement
   b. Bonds and Insurance
3. Drawings & Project Manual copies
4. Permits
   a. Contractor obtain permits
   b. Others
5. Civil Rights Requirements, Disadvantaged Business Enterprise (DBE) Utilization
6. Contractor's Health and Safety Plan and Representative
   a. Hazardous Materials Safety Briefing
   b. Permits: Hot Work and Confined Spaces
   c. OSHA Part 126 Safety and Health Regulations
   d. OSHA Log and Summary of Injuries Illness Form No. 200
   e. Two references
7. Contractor's Use of Site
   a. Site and Building Access
   b. Working Hours
   c. Staging Areas
   d. Office, Parking, Restrooms, Trash, Recycling
   e. Electric Power
   f. Water Supply
   g. Bench Marks
   h. Underground Utilities
8. Owner's Use of Site
   a. Primary Delivery Routes
   b. Restricted Areas
9. Project Communication Procedures
   a. Field Decisions
   b. Submittal Procedures
   c. Changes and Clarification Procedures
10. Schedule of Values
11. Progress Payment Procedures and Schedule
    a. Payroll Documentation
12. Project Meetings
13. Project Schedules
14. Critical Path Work Items
15. Major Product Delivery Schedules
16. Drainage and Erosion/Sedimentation Control Plan
17. Structural Special Inspections
18. Record Drawing tracking

1.4 PROGRESS MEETINGS

A. Schedule regular periodic meetings. The progress meetings will be held every 30 days with the first meeting 30 days after the pre-construction meeting or 30 days after the date of Notice to Proceed.

B. Hold called meetings as required by progress of the work.

C. Location of the meetings: Flint Water Treatment Plant Conference Room or other Owner-furnished space at the Flint WTP.

D. Attendance:
1. Engineer and his/her professional consultants as needed.
2. Owner's Representative(s)
3. Regulators
4. Subcontractors as appropriate to the agenda.
5. Suppliers as appropriate to the agenda.
6. Others as appropriate.

E. Suggested Agenda
1. Review, approval of minutes of previous meeting.
2. Review of work progress since previous meeting.
3. Field observations, problems and conflicts.
4. Problems which impede Construction Schedule.
5. Review of off-site fabrication, delivery schedules.
6. Corrective measures and procedures to regain projected schedule.
7. Revisions to Construction Schedule.
8. Progress, schedule, during succeeding work period.
9. Coordination of schedules.
10. Review submittal schedules; expedite as required.
11. Maintenance of quality standards.
12. Pending changes and substitutions.
13. Review proposed changes for:
    a. Effect on Construction Schedule and on completion date.
    b. Effect on other contracts of the project.
14. Project Safety
15. Coordination with Operations
16. Storm Water Management, Housekeeping, and Project Neighbors
17. Disadvantaged Business Enterprise (DBE) Utilization
18. Maintaining Record Documents
19. Other business.
20. Construction schedule.
21. Critical/long lead items.

F. Attend progress meetings and is to study previous meeting minutes and current agenda items, in order to be prepared to discuss pertinent topics such as deliveries of materials and equipment, progress of the work, etc.

G. Contractor to provide a current submittal log at each progress meeting in accordance with Section 013300 – Submittal Procedures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013119

SECTION 013213 – CONTROL OF WORK

PART 1 - GENERAL

1.1 WORK EFFICIENCY

A. Furnish equipment which will be efficient, appropriate and large enough to secure a satisfactory quality of work and a rate of progress which will ensure the completion of the work within the Contract Time. If at any time such equipment appears to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, Engineer may order the Contractor to increase the efficiency, change the character or increase the plant equipment and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.2 PRIVATE LAND

A. Do not enter or occupy private land outside of the work area, except by permission of the land owner.

1.3 PIPE LOCATIONS

A. Locate pipelines substantially as indicated on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference with existing structures or for other reasons. Where fittings are noted on the Drawings, such notation is for the Contractor's convenience and does not relieve him from laying and jointing different or additional items where required.

1.4 OPEN EXCAVATIONS

A. Adequately safeguard all open excavations by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workers. Remove bridges provided for access during construction when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions but shall always be confined to the limits prescribed by the Engineer. If the excavation becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.

1.5 TEST PITS

A. Excavate test pits, at the direction of the Engineer, to locate underground pipelines or structures in advance of the construction. Backfill test pits immediately after their purpose has been satisfied and restore and maintain the surface in a manner satisfactory to the Engineer.

1.6 WORK HOURS AND NOISE CONTROL

A. Contractor regular work hours shall be restricted to 8:00 a.m. to 5:00 p.m. unless prior approval has been given by Owner.

B. Special Work Hours
   1. The Contractor may request special work hours. Special work hours required by the Contractor will be considered in good faith by the Owner. However, the Owner can refuse special work hour requests for any reason. If special work hour requests are approved by the Owner, the Contractor agrees that this Work will be considered normal and customary. No additional compensation will be allowed for special work hours requested by the Contractor.
   2. Special work hours may be requested by the Owner to coordinate installation activities of this project with other activities within these facilities and other activities. The Owner will provide access to the Site and security personnel for the duration of this work. This work will be considered as additional effort provided by the Contractor at the Owner's request that was not anticipated prior to the bid. Therefore, the Owner will allow a contract modification equal to the difference between normal and overtime work rates for the Contractor provided personnel if any.

C. Noise on the Construction site shall be managed to comply with City ordinances where the project is located.

1.7 MAINTENANCE OF TRAFFIC AND ACCESS

A. Contractor shall establish a secure construction entrance as identified in the drawings. All construction traffic shall access the site through this entrance.

B. Construction traffic shall be limited to the work areas shown on the Drawings. The layout of traffic patterns must allow people and vehicles to travel to their needed locations without allowing access to other parts of the site.

C. Detours around construction will be subject to the approval of the Owner and the Engineer. Detours should consider foot traffic and vehicle traffic within the plant and campus. Where detours are permitted, provide all necessary barricades and signs as required to divert the flow of traffic. Expedite construction operations while traffic is detoured.

D. Take precautions to prevent injury to staff due to open trenches. Be fully responsible for damage or injuries whether or not protection has been provided.

E. Material Deliveries
   1. Contractor shall coordinate all material deliveries and pickups through the designated construction gate. Deliveries will not be allowed at the main gate.
   2. The Owner reserves the right to inspect any vehicle requesting access to the Site.
   3. The Owner reserves the right to refuse access to delivery vehicles and/or delivery persons for any reason.

1.8 CARE AND PROTECTION OF PROPERTY

A. Be responsible for the preservation of all public and private property and use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work on the part of the Contractor, restore such property to a condition similar or equal to that existing before the damage was done, or make good the damage in other manner acceptable to the Engineer.

1.9 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. Assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables, whether or not they are shown on the Drawings. Carefully support and protect all such structures and utilities from injury of any kind. Immediately repair any damage resulting from the construction operations.

B. The Contractor shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines and sewers). Maintain services to buildings and pay costs or charges resulting from damage thereto.

C. Notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays and Legal holidays) before excavating in any public right-of-way.

D. If, in the opinion of the Engineer, permanent relocation of a utility is required, the Engineer may direct the Contractor, in writing, to perform the work. Work so ordered will be paid for at the Contract unit prices, if applicable, or as extra work under Article 11 of the General Conditions. If relocation of a privately owned utility is required, the Owner will notify the Utility to perform the work as expeditiously as possible. Cooperate with the Owner and Utility. No claim for delay will be allowed due to such relocation.

1.10 WATER FOR CONSTRUCTION PURPOSES

A. Water shall be obtained as a ‘Hydrant Commercial Permit’, as described on the City website.

1.11 MAINTENANCE OF FLOW

A. Provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. Discuss the entire procedure of maintaining existing flow with the Engineer well in advance of the interruption of any flow.

1.12 COOPERATION WITHIN THIS CONTRACT

A. All firms or persons authorized to perform any work under this Contract shall cooperate with other Contractor and Subcontractors or trades and assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.13 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

A. During the course of the work, keep the site of operations as clean and neat as possible. At the end of each day, Contractor shall clean all public streets and land of soil deposited by vehicles leaving the site and all debris wind-blown off of the site at the end of every working day. Dispose of all residue resulting from the construction work and, at the conclusion of the work, remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and leave the entire site of the work in a neat and orderly condition.

B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, comply with all applicable Federal, State and local laws and regulations concerning waste material disposal, as well as the specific requirements stated in this Section and in other related sections.

C. Disposal of excess excavated material in wetlands, stream corridors and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The Contractor will be required to remove the fill and restore the area impacted at no increase in the Contract Price.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013213

SECTION 013216 – CONSTRUCTION SCHEDULING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. A Critical Path Method (CPM) construction schedule shall be used to control the Work and to provide a basis for determining job progress. The construction schedule shall be prepared and maintained by the Contractor. All work shall be done in accordance with the established CPM schedule. The Contractor and all subcontractors shall cooperate fully in developing the construction schedule and in executing the work in accordance with the CPM schedule.

B. The construction schedule shall consist of a computerized CPM network (diagram of activities) presented in a time-scaled graphic (print-out) with reports, as specified herein.

1.2 SUBMITTALS

A. Contractor shall submit Interim, Preliminary, Baseline (also known as "as-planned") CPM schedules, revisions, and Monthly Status Reports, all including graphics, reports, and narratives, and an as-built schedule, as specified herein.

PART 2 - PRODUCTS

2.1 SOFTWARE

A. Unless otherwise approved by the Engineer, the computer-based schedule shall be generated using Microsoft Project, Oracle-Primavera Contractor, or P6 Professional Project Management Software.

2.2 NETWORK REQUIREMENTS

A. Each schedule submittal shall contain the following identifying information:
   1. Project Title, Owner's Contract Number, and the Project Number.
   2. Contractor's name.
   3. All Contract milestones, as specified.
   4. The project calendar(s) (including work week and holidays).
   5. Type of submittal (e.g., Interim, Preliminary, Baseline, or Monthly Status Report).
   6. A summary of contract milestones.
   7. Data date and run (print) date.

B. The network of activities shall show the order and inter-dependence of activities; and, show the sequence in which the work is to be accomplished, as planned by the Contractor. The basic concept of a network analysis diagram shall be followed to show how each activity is dependent on preceding activities (predecessors) and following activities (successors).

C. Detailed network activities shall include, but are not limited to:
   1. Mobilization activities.
   2. Procurement activities (submittals, review and approval, fabrication, and delivery).
   3. Construction activities (including demolition, rehabilitation, new construction and testing).
   4. Required plant shutdowns.
   5. Maintenance of existing facilities.
   6. Test and start-up activities (including testing, start-up, training, performance testing, and commissioning).
   7. Contract milestones (fixed and floating).
   8. Specified sequences, outages and coordination activities.
   9. Any other activities needed to properly identify the scope of work and contract requirements.

D. All activities shall be sufficiently identified and/or described so that the scope of work of each activity is clear. All work tasks shall be broken down into appropriate scopes and durations to facilitate monitoring progress. Unless otherwise approved by the Engineer, no activities shall have durations of more than one month; except for off-site activities such as procurement and delivery of materials and equipment - or administrative or management activities that span the project duration that do not reflect earned progress.

E. Network activities shall be organized (grouped) by phases (or stages), physical areas, buildings, elevations, or other portions of the project.

F. Separate network activities shall be provided for each significant identifiable function in each trade area in each facility. Separate network activities shall be provided for subcontractors.

G. The number of network activities, sufficiency of description, and level of breakdown shall be subject to the Engineer's review and approval to confirm conformance with the specified requirements.

H. The format of the schedule network graphic shall be a time-scaled logic diagram - with a list of network activities and the specified data fields presented adjacent to the graphic display.

I. The following general requirements also apply to the network diagram.
   1. The Critical Path (the sequence of project network activities that add up to the longest overall duration and thereby determines the shortest time possible to complete the project) shall be identified – preferably in 'red'.
   2. Unless otherwise approved by the Engineer, the Contractor's work schedule shall be based on 'normal work week' as defined in the Contract Documents – (typically 40 hours per week, consisting of five 8-hour days).
   3. The graphics shall indicate the calendar(s) on which activity durations are based (i.e., 5-day workweek or 7 calendar day week). When multiple calendars or work weeks are used, the graphics shall clearly indicate which calendars are used where.
   4. The project calendar shall include exclusions for holidays observed by the Contractor and those indicated in the Contract Documents.

J. Each network activity shall have the following information (fields) listed alongside the activity on the graphic display.

1. Activity ID – a manually assigned designation (numeric or alphanumeric). The Contractor should use a logical approach to assigning identification to network activities to facilitate grouping (sorting) of activities.
2. Activity Description.
3. Original Duration – including allowances for adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
4. Percent complete – the Contractor's estimated percent complete for each network activity as of the data date for the respective report.
5. Remaining Duration - a calculated value based on Original Duration of each network activity and the estimated percent of completion for each activity.
6. Early Start Date.
7. Early Finish Date.
8. Late Start Date.
9. Latest Finish Date.
10. Total Float.

2.3 SUBMITTAL REQUIREMENTS

A. Each schedule submittal shall include the following elements:
   1. Graphics – unless otherwise approved by the Engineer, the network graphics shall be printed on paper or electronic files (PDF) of 11-inch by 17-inch sheets; including a list of activities and the specified data fields.
   2. Narrative
      a. The Narrative shall consist of a written report by the Contractor providing an overview of the schedule – specific to each submittal.
      b. The Narratives for developmental submittals, i.e., Interim and Preliminary, shall describe the Contractor's approach to executing the project Work.
      c. The Narrative for the Baseline Schedule shall:
         1) explain key activities and assumptions on which the schedule is based;
         2) describe the Critical Path;
         3) discuss key deliveries that might adversely affect the project schedule; and,
         4) explain the Contractor's approach to adverse weather interruptions – normal for the project location. Normal weather shall mean seasonally average weather conditions, as recorded by NOAA.
      d. The Narratives provided with Monthly Status Reports (updates) shall also identify:
         1) any changes the Contractor has made to the CPM logic (including any added, modified or deleted activities;
         2) any delays that have been encountered; and,
         3) remedial actions or recovery steps the Contractor will employ to arrest and/or recover from such delays.

B. Reports
   1. The following reports are required to be submitted with Baseline Schedule, when a major revision is made to the schedule, and when requested by the Engineer.
      a. Activity – a report listing all network activities, sorted by activity ID;
      b. Early Start – a report listing all network activities, sorted by Early Start date;
      c. Total Float – a report listing all network activities, sorted by Total Float (ascending from low to high); and,

d. Predecessor/Successor – a report of all activities, sorted by Activity ID that lists all predecessor and successor activities for each network activity.

2.4 ACCEPTABILITY

A. The Contractor shall submit the CPM schedule submittals, as specified, and resubmit as needed, until they are in compliance with Contract requirements.

B. The Engineer's review of the Contractor's construction schedule submittals will only be for conformance with the Contract requirements – including but not limited to contract time and work sequences specified in the contract documents. The Engineer's review of the schedule shall not include the Contractor's means and methods of construction or safety. The Engineer's concurrence, acceptance, or approval of the Contractor's schedule submittals will not relieve the Contractor from responsibility for complying with the Contract Scope, Contract Time or any other contract requirement. Any indication of concurrence, acceptance, or approval of the Contractor's schedule will only indicate a general conformance with the Contract Requirements.

C. Engineer's review of the Contractor's construction schedule submittals shall not relieve the Contractor from responsibility for any deviations from the Contract Documents unless the Contractor has in writing called Engineer's attention to such deviations at the time of submission and Engineer has given written concurrence to the specific deviations, nor shall any concurrence by the Engineer relieve Contractor from responsibility for errors and omissions in the submittals. Concurrence of the CPM Activity Network by the Engineer is advisory only and shall not relieve the Contractor of responsibility for accomplishing the Work within the Contract completion date(s).

D. Concurrence, acceptance, or approval of the Contractor's CPM schedule by the Engineer in no way makes the Engineer an insurer of the CPM schedule's success, nor liable for time or cost overruns resulting therefrom.

E. Failure to include any element of work required for the performance of this Contract will not excuse the Contractor from completing all Work required within the Contract completion date(s), notwithstanding the review of the network by the Engineer.

F. CPM schedules that contain activities with negative float, or which extend beyond the contract completion date, will not be acceptable.

G. Except where earlier completions are specified, CPM schedules which show completion of all work prior to the contract completion date may be indicated; however, in no event shall they constitute a basis for claim for delay by the Contractor.

PART 3 - EXECUTION

3.1 IMPLEMENTATION SCHEDULE

A. Interim Schedule
   1. Within 15 days following the receipt of the Notice to Proceed, submit an Interim Schedule indicating the planned operations during the first 60 calendar days after Notice

to Proceed. In addition, the Contractor shall indicate its general approach for the balance of the project.

2. While the Preliminary schedule is being developed, the Contractor shall update the Interim schedule on a monthly basis – indicating actual progress – until the Preliminary schedule is submitted.

B. Preliminary Schedule

1. Within 30 days following the receipt of Notice to Proceed, submit a proposed Preliminary Schedule to the Engineer. The Preliminary Schedule shall consist of a draft computer-generated CPM-schedule showing the entire Scope of Work. The Preliminary Schedule shall not include any actual progress earned during development of the schedule (i.e., statused as of the Notice to Proceed).
2. Within 15 days of submittal of the Preliminary Schedule (i.e., within 45 days of receipt of the Notice to Proceed), meet with the Engineer to discuss the review comments.
3. Once the Preliminary Schedule is submitted, Contractor shall discontinue updating the Interim Schedule. Provide monthly updates of the Preliminary Schedule until concurrence, acceptance, or approval of the Baseline Schedule.

C. Baseline (as-planned) Schedule

1. Within 10 days of the review meeting on the Preliminary Schedule submittal, the Contractor shall incorporate the Engineer's comments into the network and submit a Baseline Schedule. Resubmit the Baseline Schedule, as required until it is deemed acceptable as stated in paragraph 2.04, above.
2. Upon concurrence, acceptance, or approval of the Contractor's initial Baseline Schedule, statused as of the Notice to Proceed date, it shall be recognized as the basis against which the Contractor's progress shall be measured.

D. Monthly Status Reports

1. Monthly Status Reports shall include updated graphics and a narrative. In addition, if requested by the Engineer, Contractor shall provide copies of one or more of the standard reports listed in 2.03.B.
2. The Contractor shall provide Monthly Status Reports (schedule updates) with applications for payment commencing approximately 30 days after submission of the Interim Schedule. Unless approved otherwise by the Engineer, the Monthly Status Reports shall be statused as of the end of each calendar month.
3. While the Preliminary Schedule is being developed, the Contractor shall update the Interim schedule on a monthly basis – indicating actual progress – until the Preliminary Schedule is submitted.
4. While the Baseline Schedule is being developed, the Contractor shall update the Preliminary Schedule on a monthly basis – indicating actual progress – until concurrence, acceptance, or approval of the Baseline Schedule.
5. Once the initial Baseline Schedule is complete, Monthly Status Reports shall be based on the Baseline Schedule.

E. As-Built Schedule

1. Upon achieving Substantial Completion, the Contractor shall submit an as-built schedule, showing all activities from the Notice to Proceed through Substantial Completion. In addition, provide the reports listed in 2.03.B. A Narrative is not required.

3.2 DELIVERABLES

A. Unless approved otherwise by the Engineer, all schedule submittals shall be printed in color on sheets 11-in by 17-in and may be divided into as many separate sheets as required.

B. Interim Schedule: Submit three copies or one electronic copy (PDF) to the Engineer.

C. Preliminary Schedule: Submit three hard (paper) copies and one electronic copy (PDF) to the Engineer.

D. Baseline Schedule: Submit three hard (paper) copies, one electronic copy (PDF), and a copy of the program files to the Engineer.

E. Monthly Status Reports: Submit three copies and one electronic copy to the Engineer; and if requested, an electronic copy of the program files for the respective update.

F. As-Built Schedule: Submit one hard copy; one electronic (PDF), and, if requested, an electronic copy of the program files.

3.3 PROGRESS REPORTING

A. Progress under the approved CPM schedule shall be reported monthly by the Contractor by submitting a Monthly Status Report. Unless otherwise approved by the Engineer, not less than seven days prior to the due date of the Monthly Status Report, the Contractor shall meet with the Engineer's representative to jointly evaluate the status of each network activity. Each activity shall be updated to reflect the actual progress (percent complete) and the actual dates activities were started and completed, as applicable.

B. The Monthly Status Report shall include an update of the computer-generated network graphics and a Narrative report. The Narrative shall include:
   1. A description of the progress during the reporting period in terms of completed activities.
   2. A summary of the Critical Path.
   3. A description or explanation of each delays to network activities.
   4. A description of problem areas, current and anticipated delaying factors and their anticipated effect on the performance of other activities and completion dates.
   5. An explanation of corrective action taken or proposed.
   6. This report, as well as the CPM Status Report, will be discussed at each progress meeting.

3.4 RESPONSIBILITY FOR SCHEDULE COMPLIANCE

A. Whenever it becomes apparent from the current CPM schedule and CPM Status Report that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the Engineer, take some or all of the following actions at no additional cost to the Owner. Submit to the Engineer for approval, a written statement of the steps intended to take to remove or arrest the delay to the critical path in the approved schedule.
   1. Increase construction manpower in such quantities and crafts,
   2. Increase the number of working hours per shift, shifts per day, working days per week,
   3. Increase the amount of construction equipment, and/or

4. Reschedule activities to maximize the concurrence of activities and comply with the revised schedule.

B. If when so requested by the Engineer, failure to submit a written statement of the steps intended to take or should fail to take such steps as approved by the Engineer, the Engineer may direct the Contractor to increase the level of effort in man-power (trades), equipment and work schedule (overtime, weekend, and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the approved schedule and the Contractor shall promptly provide such level of effort at no additional cost to the Owner.

3.5 ADJUSTMENT OF CONTRACT SCHEDULE AND COMPLETION TIME

A. If the Contractor wants or needs to make changes in his/her execution of the construction schedule that would affect the approved CPM schedule, he/she shall notify the Engineer in writing stating what changes are proposed and the reasons for the changes. If the Engineer approves such changes, the Contractor shall revise and submit a revised schedule for approval - without additional cost to the Owner. The CPM schedule shall be adjusted by the Contractor only after prior approval of his/her proposed changes. Adjustments may consist of changing portions of the activity sequence, activity durations, division of approved activities, or other adjustments as may be approved by the Engineer; however, the addition of extraneous, non-working activities and activities that add unapproved restraints to the CPM schedule will not be allowed.

B. Shop drawings that are not approved on the first submittal will require the addition of network activities for the resubmittals.

C. Equipment that does not pass the specified tests will require the addition of network activities for the retesting.

D. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, he/she shall furnish such justification and supporting evidence as the Engineer may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract. After receipt of such justification and supporting evidence, the Engineer's shall perform an assessment or evaluation of the appropriate change in contract time based upon the currently approved CPM schedule and on all data relevant to the extension. Inexcusable delays (attributable to the Contractor) and non-critical delays (delays to activities which, according to the CPM schedule, do not affect any contract completion date shown by the Critical Path) shall not be the basis for a change in contract time. The Engineer will provide a written recommendation to the Owner based on its assessment, with a copy to the Contractor. The Contractor shall not change any fixed contract milestones or required completion dates without the approval of the Owner, evidenced by the execution of a contract change order. However, the Contractor should make note of such requests for changes in contract time in the narrative of monthly schedule status reports.

E. Each request for change in any contract completion date shall be submitted by the Contractor to the Engineer in accordance with the notification requirements stipulated in the form of contract or general conditions. No time extension will be granted for requests that are not submitted in accordance with the Contract requirements.

F. Total float in the approved CPM network belongs to the project; i.e., the Owner may take advantage of available total float. Therefore, without obligation to extend either the overall completion date, or any intermediate completion dates set out in the CPM network, the Owner may initiate changes to the work or delay work that absorb available total float existing at the time of the change or delay. Owner initiated changes or delays that affect the Critical Path on the approved CPM network shall be the sole grounds for extending (or contracting) contract completion dates or fixed milestones.

END OF SECTION 013216

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes the requirements for compiling, processing and transmitting submittals required for execution of the project.

B. Submittals are categorized into two types: Action Submittals and Informational Submittals, as follows:
   1. Action Submittal: Written and graphic information submitted by the Contractor that requires the Engineer's approval. The following are examples of action submittals:
      a. Shop drawings (including working drawings, valve schedule in accordance with Section 013300, and product data)
      b. Samples
      c. Operation & maintenance manuals
      d. Site Usage Plan (Contractor's staging - including trailer siting and material laydown area)
      e. Schedule of values
      f. Payment application format
   2. Informational Submittal: Information submitted by the Contractor that does not require the Engineer's approval. The following are examples of informational submittals:
      a. Shop drawing schedule
      b. Construction schedule
      c. Statements of qualifications
      d. Health and Safety Plans, Training Records and Injury Logs
      e. Construction photography and videography
      f. Work plans
      g. Outage requests
      h. Proposed testing procedures
      i. Test records and reports
      j. Vendor training outlines/plans
      k. Test and start-up reports
      l. Certifications
      m. Record Drawings
      n. Record Shop Drawings
      o. Submittals required by laws, regulations and governing agencies
      p. Submittals required by funding agencies
      q. Other requirements found within the technical specifications
      r. Warranties and bonds
      s. As-built surveys
      t. Contract close-out documents

1.2 RELATED WORK

A. Additional requirements may be specified in the General Conditions for the Contract.

B. Additional submittal requirements may be specified in the respective technical Specification Sections.

C. Applications for Payment are included in Section 012000.

D. Requests for Information are included in Section 013000.

E. Construction Schedules are included in Section 013216.

F. Construction Photos are included in Section 013593.

G. Operation and Maintenance manuals are included in Section 017823.

H. Warranties and Bonds are included in Section 017836.

I. Project Record Documents are included in Section 017839.

1.3 CONTRACTOR'S RESPONSIBILITIES

A. All submittals shall be clearly identified as follows:
1. Date of submission
2. Project number
3. Project name
4. Contractor identification
    a. Contractor
    b. Supplier
    c. Manufacturer
    d. Manufacturer or supplier representative
5. Identification of the product
6. Reference to Contract drawing(s)
7. Reference to specification section number, page and paragraph(s)
8. Reference to applicable standards, such as ASTM or Federal Standards numbers
9. Indication of Contractor's approval
10. Contractor's Certification statement
11. Identification of deviations from the Contract Documents, if any
12. Reference to previous submittal (for resubmittals)

B. Submittals shall be clear and legible, and of sufficient size for legibility and clarity of the presented data.

C. Submittal Log. Maintain a log of all submittals. The submittal log shall be kept accurate and up to date. This log should include the following items (as applicable):
1. Description
2. Submittal number
3. Date transmitted to the Engineer
4. Date returned to Contractor (from Engineer)
5. Status of Submittal (Approved/Not Approved/etc.)
6. Date of Resubmittal to Engineer and Return from Engineer (if applicable and repeat as necessary)
7. Date material released for fabrication

8. Projected (or actual) delivery date

D. Numbering System. Utilize a 10-character submittal identification numbering system in the following manner:
   1. The first character shall be a D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.
   2. The next six digits shall be the applicable Section Number.
   3. The next two digits shall be the numbers 01 to 99 to sequentially number each separate item or drawing submitted under each specific Specification Section, in the order submitted.
   4. The last character shall be a letter, A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc. A typical submittal number would be as follows:
      a. D-461322-08-B
      b. D = Shop Drawing
      c. 461322 = Section for the Tank
      d. 08 = the eighth different submittal under this section
      e. B = the second submission (first resubmission) of that particular shop drawing.

E. Variances
   1. Notify the Engineer in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents
   2. Notify the Engineer in writing, at the time of re-submittal (resubmission), of all deviations from previous submissions of that particular shop drawing, except those deviations which are the specific result of prior comments from the Engineer.

F. Action Submittals
   1. Shop Drawings, Working Drawings, Product Data and Samples
      a. Shop Drawings
         1) Shop drawings as defined in the General Conditions, and as specified in individual Sections include, but are not necessarily limited to, custom prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, valve schedule, wiring diagrams, coordination drawings, equipment inspection and test reports, including performance curves and certifications, as applicable to the work.
         2) Contactor shall verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and coordinate each item with other related shop drawings and the Contract requirements.
         3) All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.
         4) All shop drawings submitted by subcontractors and vendors shall be reviewed by the Contractor for field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and that it has been coordinated with other related shop drawings and the Contract requirements. Submittals directly from subcontractors or vendors will not be accepted by the Engineer.

5) The Contractor shall be responsible for the accuracy of the subcontractor's or vendor's submittal; and, for their submission in a timely manner to support the requirements of the Contractor's construction schedule. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractor or vendor to correct before submission to the Engineer. All shop drawings shall be approved by the Contractor.
6) Delays to construction due to the untimely submission of submittals will constitute inexcusable delays, for which Contactor shall not be eligible for additional cost nor additional contract time. Inexcusable delays consist of any delay within the Contactor's control.
7) Submittals for equipment specified under each Division shall include a listing of installations where identical or similar equipment manufactured by that manufacturer has been installed and in operation for a period of at least five years.

b. Working Drawings
1) Detailed installation drawings (equipment, piping, electrical conduits and controls, HVAC work, and plumbing, etc.) shall be prepared and submitted for review and approval by the Engineer prior to installing such work. Installation drawings shall be to-scale and shall be fully dimensioned.
2) Piping working drawings shall show the laying dimensions of all pipes, fittings, valves, as well as the equipment to which it is being connected. In addition, all pipe supports shall be shown.
3) Equipment working drawings shall show all equipment dimensions, anchor bolts, support pads, piping connections and electrical connections. In addition, show clearances required around such equipment for maintenance of the equipment.
4) Electrical working drawings shall show conduits, junction boxes, disconnects, control devices, lighting fixtures, support details, control panels, lighting and power panels, and Motor Control Centers. Coordinate all locations with the Contract Documents and the Contractor's other working drawings.
5) All custom shop drawings prepared by equipment manufacturer or Control System Integrator must follow the Owner’s standards and format. More extensive definitions of the standards will be distributed to successful bidders.
a) All drawings must be formatted to fit the Owner’s title block and borders. Electronic title block and border files will be provided by the Owner for companies under contract to do work. Shop drawings and other preliminary drawings may be submitted using a company's standard title blocks or the Owner’s title blocks. Final submitted drawings must use the Owner’s title block and sheet border (22 by 34 inches with the title block across the bottom).
b) All drawings will include sheet numbering in the Owner’s file system. Cross referencing between sheets must use the Owner’s sheet numbering system. If the company has their own standard sheet numbering system, those numbers may be used in addition to the Owner’s system.
c) The only exception to the drawing standards will be allowed for equipment that is mass-produced, and commonly can be a "shelf-stocked" item.

6) All projects will have a meeting before drawings are prepared. Each company that will prepare drawings should bring examples of previous drawings. The Owner will also bring examples. Separate meetings will be required for the following types of drawings.
   a) Process and Instrumentation Diagram (P&ID) - A detailed tagging system has been developed for all components that will be shown on P&ID's as well as other drawings. The tagging method must be used in PLC and SCADA programming.
   b) Mechanical, Process, Structural Drawings - Cross Section and Detail referencing will follow the Owner's standards.
   c) Electrical Schematic Drawings – The Owner uses a "Row and Column" drawing format, which is one of the formats developed by the ISA (The Instrumentation, Systems, and Automation Society). All devices and wires on every electrical schematic must be numbered to allow direct referencing back to the specifically related ladder rung on the schematic and the Panel (or PLC) number. The schematic column arrangement will follow the Owner's standards. PLC diagrams will have similar column numbers for every PLC.
7) All final drawings must be submitted to the Owner electronically in a CAD format, using a current version of Auto CADD.

c. Product Data
   1) Product data, as specified in individual Specification Sections, include, but are not limited to, the manufacturer's standard prepared data for manufactured products (catalog data), such as the product specifications, installation instructions, availability of colors and patterns, rough-in diagrams and templates, product photographs (or diagrams), wiring diagrams, performance curves, quality control inspection and reports, certifications of compliance (as specified or otherwise required), mill reports, product operating and maintenance instructions, recommended spare parts and product warranties, as applicable.

d. Samples
   1) Furnish, samples required by the Contract Documents for the Engineer's approval. Samples shall be delivered to the Engineer as specified or directed. Unless specified otherwise, provide at least two samples of each required item. Materials or equipment for which samples are required shall not be used in the work unless and until approved by the Engineer.
   2) Samples specified in individual Specification Sections, include, but are not limited to: physical examples of the work (such as sections of manufactured or fabricated work), small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and other specified units of work.
   3) Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify and Contract Requirements.
   4) Approved samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Approved samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved samples. Samples which fail testing or are not approved will be returned to the Contractor at his expense, if so requested at time of submission.

e. Professional Engineer (P.E.) Certification Form
   1) If specifically required in any of the technical Specification Sections, submit a Professional Engineer (P.E.) Certification for each item required, using the form appended to this Section, signed and sealed by the P.E. licensed or registered in the state wherein the work is located.

2. Contractor's Certification
   a. Each shop drawing, working drawings, product data, and sample shall have affixed to it the following Certification Statement:
      1) "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."
      2) Shop drawings without the certification statement affixed will not be reviewed.
   b. Shop drawings, working drawings, and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The transmittal cover sheet for each identified shop drawing shall fully describe the packaged data and include a listing of all items within the package.
3. The review and approval of shop drawings, working drawings, product data, or samples by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefore.
4. Project work, materials, fabrication, and installation shall conform to approved shop drawings (including working drawings and product data) and applicable samples.
5. No portion of the work requiring a shop drawing (including working drawings and product data) or sample shall be started, nor shall any materials be fabricated or installed before approval of such item. Procurement, fabrication, delivery or installation or products or materials that do not conform to approved shop drawings shall be at the Contractor's risk. Furthermore, such products or materials delivered or installed without approved shop drawings, or in non-conformance with the approved shop drawings will not be eligible for progress payment until such time as the product or material is approved or brought into compliance with approved shop drawings. Neither the Owner nor Engineer will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
6. Operation and Maintenance Data
   a. Refer to Section 017823 for O&M data requirements.
7. Schedule of Values
   a. On projects consisting of lump sums (in whole or in part) submit a proposed schedule of values providing a breakdown of lump sum items in to reasonably small components – generally disaggregated by building, area, and/or discipline. The purpose of the schedule of values is for processing partial payment applications. If requested by the Engineer, provide sufficient substantiation for all or some items as necessary to determine the proposed schedule of values is a reasonable representation of the true cost breakdown of the Work. The schedule of values shall not be unbalanced to achieve early payment or over-payment in excess of the value of work or any other mis-distribution of the costs. If, in the opinion of the Engineer, the schedule of values is unbalanced, Contractor shall reallocate components to achieve a balanced schedule acceptable to Engineer. Also, see Section 013592.

8. Payment Application Format
    a. See Section 012000 – 1.04.A for payment application information.
9. Site Usage
    a. Submit a proposed site staging plan, including but not limited to the location of office trailers, storage trailers and material laydown. Such plan shall be a graphic presentation (drawing) of the proposed locations; and, shall include on-site traffic modifications, and temporary utilities, as may be applicable.

G. Informational Submittals
1. Shop Drawing Schedule
    a. Prepare and submit a schedule indicating when shop drawings are required to be submitted to support the as-planned construction schedule. The submittal schedule shall allow sufficient time for preparation and submittal, review and approval, and fabrication and delivery to support the construction schedule.
2. Construction Schedule
    a. Prepare and submit construction schedules and monthly status reports as specified.
3. Statement of Qualifications
    a. Provide evidence of qualification, certification, or registration, as required in the Contract Documents, to verify qualifications of licensed land surveyor, professional engineer, materials testing laboratory, specialty subcontractor, technical specialist, consultant, specialty installer, and other professionals.
4. Health and Safety Plans
    a. When specified, prepare and submit a general company Health and Safety Plan (HSP), modified or supplemented to include job-specific considerations.
    b. Submit Contractor safety program, safety logs and other information requested in Section 01 35 00 – Safety Procedures.
5. Construction Photography and Videography
    a. Provide periodic construction photographs and videography as specified – including but not limited to preconstruction photographs and/or video, monthly progress photos and/or video and post-construction photographs and/or video.
6. Work Plans
    a. Prepare and submit copies of all work plans needed to demonstrate to the Owner that Contractor has adequately thought-out the means and methods of construction and their interface with existing facilities.
7. Maintenance of Traffic Plans
    a. Prepare maintenance of traffic plans where and when required by the Contract Documents and by local ordinances or regulations. If Contractor is not already knowledgeable about local ordinances and regulations regarding maintenance of traffic requirements, become familiar with such requirements and include all costs for preparation and submittal of traffic management plans and all associated costs for permits and fees to implement the traffic management plan, in the bid amount. In addition, unless a supplemental payment provision is provided in the bid form, include the cost of police attendance, when required.
8. Outage Requests
    a. Provide sufficient notification of any outages required (electrical, flow processes, etc.) as may be required to tie-in new work into existing facilities. Unless specified otherwise elsewhere, a minimum of seven calendar days' notice shall be provided.
9. Proposed Testing Procedures
    a. Prepare and submit testing procedures it proposes to use to perform testing required by the various technical specifications.
10. Test Records and Reports

a. Provide copies of all test records and reports as specified in the various technical specifications.

11. Vendor Training Outlines / Plans
    a. At least two weeks before scheduled training of Owner's personnel, provide lesson plans for vendor training in accordance with the specification for O&M manuals.
12. Test and Start-Up Reports
    a. Manufacture shall perform all pre-start-up installation inspection, calibrations, alignments, and performance testing as specified in the respective Specification Section. Provide copies of all such test and start-up reports.
13. Certifications
    a. Provide various certifications as required by the technical specifications. Such certifications shall be signed by an officer (of the firm) or other individual authorized to sign documents on behalf of that entity.
14. Certifications may include, but are not limited to:
    a. Welding certifications and welders qualifications.
    b. Certifications of Installation, Testing and Training for all equipment.
    c. Material Testing reports furnished by an independent testing firm.
    d. Certifications from manufacturer(s) for specified factory testing.
    e. Certifications required to indicate compliance with any sustainability or LEEDS accreditation requirements indicated in the Contract Documents.
15. Record Drawings
    a. No later than Substantial Completion, submit a record of all changes during construction not already incorporated into drawings – in accordance with specification on Project Record Documents.
16. Record Shop Drawings
    a. Before final payment is made, furnish one set of record shop drawings to the Engineer. These record shop drawings shall be in conformance with the approved documents and should show any field conditions which may affect their accuracy.
17. Submittals required by laws, regulations and governing agencies.
    a. Prepare and submit all documentation required by state or local law, regulation or government agency directly to the applicable agency. This includes, but is not limited to, notifications, reports, certifications, certified payroll (for projects subject to wage requirements) and other documentation required to satisfy all requirements. Provide to Engineer one copy of each submittal made in accordance with this paragraph.
18. Other requirements of the technical Specification Sections
    a. Assemble a book(let) of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds and provide to the Engineer.
19. Warranties and bonds
    a. Assemble a book(let) of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds and provide to the Engineer.
20. As-Built Surveys
    a. Engage the services of a licensed land surveyor in accordance with the Project Controls specification. Prior to Final Completion, provide an as-built survey of the constructed facility, as specified.
21. Contract close-out documents
    a. Submit Contract documentation as indicated in the specification for Contract Close-out.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SUBMITTAL SCHEDULE

A. Provide an initial submittal schedule at the pre-construction meeting for review by Owner and Engineer. Incorporate comments from Owner or Engineer into a revised submittal schedule.

B. Maintain the submittal schedule and provide sufficient copies for review by Owner and Engineer. An up-to-date submittal schedule shall be provided at each project progress meeting.

3.2 TRANSMITTALS

A. Prepare separate transmittal sheets for each submittal. Each transmittal sheet shall include at least the following: the Contractor's name and address, Owner's name, project name, project number, submittal number, specification number, description of submittal and number of copies submitted.

B. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.

C. Provide copies of transmittals only (i.e., without copies of the respective submittal) directly to the Resident Project Representative.

3.3 PROCEDURES

A. Action Submittals
   1. Contractor’s responsibilities
      a. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required). Coordinate with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. Extensions to the Contract Time will not be approved for the Contractor's failure to transmit submittals sufficiently in advance of the Work.
      b. The submittals of all shop drawings (including working drawings and product data) shall be sufficiently in advance of construction requirements to allow for possible need of re-submittals, including the specified review time for the Engineer.
      c. No less than 21 calendar days will be required for Engineer's review time for shop drawings and O&M manuals involving only one engineering discipline. No less than 28 calendar days will be required for Engineer's review time for shop drawings and O&M manuals that require review by more than one engineering discipline. Resubmittals will be subject to the same review time.

d. Submittals of operation and maintenance data shall follow procedure in Section 017823.

e. Before submission to the Engineer, review shop drawings as follows:
   1) make corrections and add field measurements, as required
   2) use green ink for comments. Red is reserved for Engineer's notations.
   3) identify and describe each and every deviation or variation from Contract documents or from previous submissions, except those specifically resulting from a comment from the Engineer on a previous submission
   4) include the required Contractor's Certification statement
   5) provide field measurements (as needed)
   6) coordinate with other submittals
   7) indicate relationships to other features of the Work
   8) highlight information applicable to the Work and/or delete information not applicable to the Work

f. Submit the following number of paper copies:
   1) Shop drawings (including working drawings and product data) – Submit no fewer than seven. Four copies to be retained by the Owner and Engineer. Three will be returned to the contractor. Contractor shall adjust the total number of shop drawings submitted if the Contractor would like more copies returned for Contractor distribution.
   2) Samples – three
   3) Site Usage Plan – three copies
   4) Schedule of values – four copies
   5) Payment application format – four copies
   6) Operation and Maintenance Manuals – Submit 2 preliminary copies and three final copies

g. Electronic Submittals shall comply with the following format conditions.
   1) Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Document shall be readable by at least the most recent three versions of Adobe Acrobat Reader.
   2) Electronic files that contain more than 15 pages in PDF format shall contain internal bookmarking.
   3) PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, (or 22-inch by 34-inch with prior approval from Owner or Engineer).
   4) Submit new, complete electronic files for each resubmittal.
   5) Use the following file name format for submittals:
      a) Example: 099700_86_Special_Coatings.pdf
      b) Where:
         (1) **099700_** - is the specification section number (without spaces if 49 division format). Include an underscore after the section number.
            (a) Use 099700-2-05_ if the submittal only includes products from article 2.05 of the section and there are other submittals for other articles. Use dashes, not periods. If the submittal includes products from multiple articles, do not include the articles numbers.
         (2) **86_**- is the submittal number (contractor sequence #). Include an underscore after the number.
            (a) Use 2 digits only for first 99 submittals, and 3 digits after that.

(b) Use 86B_ for resubmittal (then 86C_, etc.).

(3) **Special_Coatings.pdf** is a short description. Generally limit file names to about 35 characters or less. Abbreviations are acceptable and recommended. Underscores between words are preferred.

c) Use file name like **Layout_45_item_name.pdf** is there is a submittal to confirm a design or configuration where there is no directly related specification. The text in the location of **45_** is the submittal number.

d) If multiple files are used for an individual Shop Drawing, then add information to the end of the description (e.g. _Xmtl for transmittal, _Part1, _Part2, etc.)

h. If Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, provide written notice thereof to the Engineer immediately; and do not release for manufacture before such notice has been received by the Engineer.

i. When the shop drawings have been completed to the satisfaction of the Engineer, carry out the construction in accordance therewith; and make no further changes therein except upon written instructions from the Engineer.

2. Engineer's Responsibilities

a. Engineer will not review shop drawings (including working drawings and product data) that do not include the Contractor's approval stamp. Such submittals will be returned to the Contractor, without action, for correction.

b. Partial shop drawings (including working drawings and product data) will not be reviewed. If, in the opinion of the Engineer, a submittal is incomplete, that submittal will be returned to the Contractor for completion. Such submittals may be returned with comments from Engineer indicating the deficiencies requiring correction.

c. If shop drawings (including working drawings and product data) meet the submittal requirements, Engineer will forward copies to appropriate reviewer(s). Otherwise, noncompliant submittals will be returned to the Contractor without action - with the Engineer retaining one copy.

d. Submittals which are transmitted in accordance with the specified requirements will be reviewed by the Engineer within the time specified herein. The time for review will commence upon receipt of submittal by Engineer.

3. Review of Shop Drawings (Including Working Drawings and Product Data) and Samples

a. The review of shop drawings, working drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:

1) as permitting any departure from the Contract requirements

2) as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials

3) as approving departures from details furnished by the Engineer, except as otherwise provided herein

b. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

c. If the shop drawings (including working drawings and product data) or samples as submitted describe variations and indicate a deviation from the Contract requirements that, in the opinion of the Engineer are in the interest of the Owner and are so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.

d. Only the Engineer will utilize the color "RED" in marking submittals.
e. Shop drawings will be returned to the Contractor with one of the following codes.
   1) Code 1 – "APPROVED" – This code is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.
   2) Code 2 - "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.
   3) Code 3 - "APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments is required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
   4) Code 4 - "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.
   5) Code 5 – "NOT APPROVED" – This code is assigned when the submittal does not meet the intent of the contract documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the contract documents.
   6) Code 6 – "COMMENTS ATTACHED" – This code is assigned where there are comments attached to the returned submittal, which provide additional data to aid the Contractor.
   7) Code 7 – "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Review or Approval)" – This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval and is being filed for informational purposes only. This code is generally used in acknowledging receipt of means and methods of construction work plans, field conformance test reports, and health and safety plans.
   8) Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.
f. Repetitive Reviews: Refer to Section 00 73 00 – Supplementary Conditions – SC6.17 for details on repetitive submittals resubmission.

4. Electronic Transmission
   a. Action Submittals may be transmitted by electronic means provided the following conditions are met:
      1) The above-specified transmittal form is included.
      2) All other requirements specified above have been met including, but not limited to, coordination by the Contractor, review and approval by the Contactor, and the Contractor's Certification.
      3) The submittal contains no pages or sheets large than 11 x 17 inches.

4) With the exception of the transmittal sheet, the entire submittal is included in a single file.
5) The electronic files are in a searchable PDF format (with printing enabled).
6) In addition, transmit three hard-copy (paper) originals to the Engineer.
7) The Engineer's review time will commence upon receipt of the hard copies of the submittal.
8) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit at least two hard-copy originals to the Engineer. In addition, provide additional photocopied or scanned copies, as specified above, showing the required certification, corporate seal, or professional seal.

b. Engineer review response for electronic submittals will be summarized on a memorandum near the first page of the returned file. The comments will not generally be repeated on the related pages within the shop drawing.

B. Informational Submittals
1. Contractor's Responsibilities
a. Number of copies: Submit three copies, unless otherwise indicated in individual Specification sections.
b. Refer to individual technical Specification Sections for specific submittal requirements.
2. Engineer's Responsibilities
a. The Engineer will review each informational submittal within 15 days. If the informational submittal complies with the Contract requirements, Engineer will file for the project record and transmit a copy to the Owner. Engineer may elect not to respond to Contractor regarding informational submittals meeting the Contract requirements.
b. If an informational submittal does not comply with the Contract requirements, Engineer will respond accordingly to the Contractor within 15 days. Thereafter, the Contractor shall perform the required corrective action, including retesting, if needed, until the submittal, in the opinion of the Engineer, is in conformance with the Contract Documents.
3. Electronic Transmission
a. Informational submittals may be transmitted by electronic means providing all of the following conditions are met:
1) The above-specified transmittal form is included.
2) The submittal contains no pages or sheets large than 11 x 17 inches.
3) With the exception of the transmittal sheet, the entire submittal is included in a single file.
4) The electronic files are in a searchable PDF format (printing enabled).
5) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit two hard-copy originals to the Engineer.
6) File names follow the patterns on the following examples.
a) Request for Information (RFI)
(1) RFI_C005_Location_of_Hose_Reels.doc
(2) RFI_C005_Attachment_1.pdf
(3) Where: C005_ includes first letter of requester's firm name and sequence number.
b) Change Proposal Request (CPR)
(1) Request: CPR05_Add_Paving_SW_Corner.pdf

(2) Cost from XYZ Contractor: CPR05_XYZ_cost.doc
(3) Use CPR005 (three digits for large projects)

c) Change Order (ChOr)
(1) Request: ChOr05_Add_Paving_SW_Corner.pdf
(2) Cost from XYZ Contractor: ChOr05_XYZ_cost.doc
(3) Use ChOr005 (three digits for large projects)

d) Application for Payment
(1) FFP_Rehab_ PayAppl_01_June2015_Draft.pdf
(2) FFP_Rehab_ PayAppl_01_June2015_Final.pdf
(3) Format: Project_PayAppl_##_Month_Year_status.pdf

END OF SECTION 013300

SECTION 013553 - SECURITY PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements of the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 and the Homeland Security Act of 2002 require that municipal water utilities be managed as secure locations.

B. These acts define security screening of all employee and contractor personnel, controlling access to facilities and controlling access to information as “basic security requirements” and will manage them in the following manner.

1.2 SECURITY SCREENING

A. All Contractor or Sub-Contractor personnel who will be on the project site for more than five (5) working days or have the need or opportunity to access water facility information must submit to the collection, review and approval of personal criminal background history information that will be kept on file with the City of Flint.

B. Personal criminal background information will be acquired through an independent third-party investigator that is licensed, insured and under contract with the City to perform said investigations.

C. Persons submitting to a background investigation will do so via a signed consent form. This form includes disclose of the following information:
   1. Full legal name.
   2. Current address.
   3. Social Security number.
   4. All past addresses for previous seven years.
   5. Any known aliases.

D. The background investigation will consist of searching and reporting information for all disclosed and discovered history information involving:
   1. County criminal.
   2. State criminal.
   3. Federal criminal.
   4. Global watch.

E. Personal credit history information will not be collected nor reviewed as part of this investigation.

F. All history gathered will be forwarded to the City for review and approval. The City reserves the right to deny access to its facilities and information as it deems appropriate.

G. The Contractor shall allow 10 working days from the receipt of an executed informed consent form for the City to process and review background information.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTROLLING ACCESS TO FACILITIES

A. All Contractor personnel approved by the City will be issued work identification (ID) badges. These badges must be worn at all times while on City of Flint property. ID badges allow access to the work site; identify the person, the activity and the area of the facility where personnel are allowed to enter.

B. Any persons not wearing their ID badges or frequenting unapproved areas will be escorted from the premises. If an individual is escorted from the premises more than twice, that person will be removed from the work eligible list and not allowed to return.

C. Gates onto the Flint Water Treatment Plant site access, including the construction entrance, must be locked or attended at all times.

D. NO deliveries or pickups will be allowed unless the Contractor is available for escort.

E. Any Contractor or Subcontractor personnel whose work require them to be on site for less than five total days must be escorted on to the site and under the direct supervision by contractor personnel who have successfully passed the investigation and are in position of Flint-issued ID badges.

F. Select contractor personnel who require access inside other controlled area(s) will be authorized for access as coordinated with Owner.

G. All Identification Badges and Access Cards must be returned to Owner prior to final application for payment. A fee of $100 will be deducted from final payment for each badge or card not returned.

3.2 SITE AND BUILDING ACCESS SCHEDULE

A. Contractor Gate access cards will be active from 8:00 am to 5:00 PM, Monday through Friday, except on City Holidays. Contractor shall discuss any needed exceptions to this schedule with the Owner's Project Manager in advance of the need.

3.3 GENERAL ACCESS CONTROL METHODS

A. For long-term systems, keys should not be needed for any employees or non-employees. Card readers shall be used for long-term access. Each locked building door will be keyed, but keys will not be distributed for access.

B. Keys will only be allowed for selected cabinets where other methods are impractical. Use common keying per building wherever possible. Deliver at least 4 copies of every required key to the Plant Supervisor prior to Substantial Completion.

C. All exterior doors and gates must have monitored (and alarmed) position switches.

D. All exterior doors shall have electrical boxes to allow installation of card readers. Those left for future installation must have weather-tight covers over the empty boxes.

E. Card Readers shall be included on the outside of each door, wherever people will be allowed access from outside. Request to exit switches shall be included in crash bars and hand lever, to confirm open door has not been forced.

F. Some exterior doors may be for emergency exit only, and should have no door pulls, knobs, or levers on the outside.

G. Construction Projects should require at least 3 key changes:
   1. Contractor full control – Owner only allowed to have a few keys.
   2. Owner partial occupancy – wider distribution of keys to Owner's representatives, (typically prior to card reader installation). Contractor remains in charge of keying.
   3. Owner Full Occupancy – Full control of keying by Owner (typically after installation of card readers).

3.4 CONTROLLING ACCESS TO INFORMATION

A. Contractors must sign a non-disclosure agreement defining the Contractors responsibilities for being allowed access to and provided copies of the specifications, drawings and technical information in the process control and plant security areas. The Contractor agrees it will require sub-contractors to meet all requirements of this agreement.

B. The Contractor shall also sign and maintain a "Chain-of-Custody" agreement document for the duration of the work. This agreement requires City approval of the distribution of any sensitive information as well as documentation of who/what/when and where said information is accessed or distributed.

C. Any documents developed by the Contractor in progress of the Work shall become a part of the "information" and will be subject to the requirements of this section.

END OF SECTION 013553

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SECTION 013592 – SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Submit a Schedule of Values allocated to the various portions of the work, within 21 days after the effective date of the Agreement.

B. Submit a time-based forecast of expected Owner expenses in a Payment Schedule, before the first Application for Payment.

C. Upon request of the Engineer, support the values with data which will substantiate their correctness.

D. The accepted Schedule of Values shall be used as the basis for the Contractor's Applications for Payment.

E. The accepted Schedule of Values may be used as the basis for Change Orders.

1.2 RELATED REQUIREMENTS

A. Standard General Conditions of the Construction Contract are included in Section 007213.

B. Application for Payment is included in Section 012000.

1.3 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Type schedule on 8-½-in by 11-in white paper. Contractor's standard forms and automated printout will be considered for approval by the Engineer upon Contractor's request. Identify schedule with:
   1. Title of Project and location.
   2. Engineer and Project number.
   3. Name and Address of Contractor.
   4. Contract designation.
   5. Date of submission.

B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Identify each line item with the number and title of the respective Section.

D. For each major line item, list sub-values of major products or operations under the item.

E. For the various portions of the work:
   1. Each line shall include a directly proportional amount of the Contractor's overhead and profit.

2. For items on which progress payments will be requested for stored materials, break down the value into:
   a. The cost of the materials delivered and unloaded, with taxes paid. Paid invoices are required for materials upon request by the Engineer.
   b. The total installed value.

F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.4 SUB-SCHEDULE OF UNIT MATERIAL VALUES

A. Submit a sub-schedule of unit costs and quantities for:
   1. Products on which progress payments will be requested for stored products.

B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.

C. The unit quantity for bulk materials shall include an allowance for normal waste.

D. The unit values for the materials shall be broken down into:
   1. Cost of the material delivered and unloaded at the site, with taxes paid.
   2. Copies of invoices for component material shall be included with the payment request in which the material first appears.
   3. Paid invoices shall be provided with the second payment request in which the material appears, or no payment shall be allowed and/or may be deleted from the request.

E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

1.5 FORM AND CONTENT OF PAYMENT SCHEDULE

A. In an electronic spreadsheet, compatible with Microsoft Excel, prepare a time-based forecast of expected Owner payments to Contractor. Identify schedule with:
   1. Title of Project.
   2. Name and Address of Contractor.
   3. Contract designation.
   4. Date of submission.

B. In the Schedule show estimated Application for Payment amounts, totaling all line items in the Schedule of Values planned for each work period. Deduct retainage from each work period's amount and include the total retainage as the last payment.

C. Work period in this schedule may be either monthly or quarterly for the full duration of the project.

D. The spreadsheet shall be arranged with all dates in a column and the corresponding payment in a separate column, adjacent to the date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 013592

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SECTION 013593 – CONSTRUCTION PHOTOGRAPHS AND VIDEO DOCUMENTATION

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. Contractor shall employ a competent photographer to take construction record photographs periodically during course of the Work.

1.2 PHOTOGRAPHY REQUIRED

A. Land based photography of the project. Provide photographs at following periods of construction:
   1. Prior to construction.
   2. Every 30 days until substantial completion is granted.
   3. At project completion.

B. Video survey (specified herein).

1.3 COST OF PHOTOGRAPHY

A. Contractor shall pay costs for specified videotaping photography, digital recording, and prints. Parties requiring additional photography or prints will pay photographer directly.

PART 2 - PRODUCTS

2.1 STILL PHOTOGRAPHY

A. Submit digital photographs on CD-ROM within one (1) month of the primary date of photography. Digital images shall be ‘JPG’ format, using 3 to 5 megapixel file size. A limited number of higher resolution images may be accepted for specific reasons. All photos should maintain the original and correct meta-data for ‘Date Taken’.

B. On every CD-ROM, include a memorandum that describes every photo, including photo file name, subject of photo, location, direction of view and date taken. The Title zone of the Memorandum shall include names of project, Contractor and photographer. Include the Memorandum in both word processor format and PDF.

2.2 VIDEO RECORDING

A. Specifications for Audio-Video Survey
   1. The Contractor shall perform a preconstruction Audio-Video Survey of the site in the presence of the Owner and Engineer. The preconstruction Audio-Visual Survey shall

include a recording on properties adjacent to the site to determine preconstruction conditions of the properties.

2. Video record the entire project site for a minimum recording time of one hour. Include at a minimum, existing facilities near the construction, site location of proposed work, neighboring structures that could be impacted by vibration and any standing water areas in or near construction zones.
3. Prior to the start of construction on the contract, the Contractor shall furnish to the Engineer, video recordings of the construction area. The Engineer shall review the recordings and either approved or additional coverage will be required to fully show the physical conditions of the work areas. The Contractor shall have the additional coverage recorded and shall not begin work, including moving equipment and/or material on the project site, until the audio-video survey has been approved by the Engineer. The recordings will also be used as a guide by the Engineer, prior to issuance of final payments, in determining the adequacy of restoration and the extent of damages attributable to the Contractor work.

B. Technical Requirements
1. The total audio-video recording system and the procedures employed in its use shall be such as to produce a finished product that will fulfill the technical requirements of the project, as well as those more subjective requirements of high-quality audio and video production. The video portion of the recording shall reproduce bright, sharp, clear pictures with accurate colors and shall be free from distortion, tearing, rolls or any other form of picture imperfection. The audio portion of the recording shall reproduce precise and concise explanatory notes by the camera operator with proper volume, clarity and freedom from distortion.
2. Video file for submittal to the Engineer shall be Windows Media Video (*.wmv) or MPEG-4 (*.mp4) format, with a of image size of approximately 1280 by 720 pixels.

PART 3 - EXECUTION

3.1 TECHNIQUE FOR STILL PHOTOGRAPHS

A. Factual presentation.

B. Correct exposure and focus.
1. High resolution and sharpness.
2. Maximum depth-of-field.
3. Minimum distortion.

3.2 VIEWS REQUIRED FOR LAND BASED STILL PHOTOGRAPHS

A. Contractor shall photograph from locations to adequately illustrate condition of construction and state of progress.

B. In addition, the Contractor shall photograph each major portion of the work prior to the beginning of work. Views shall be as required by the Engineer. In addition, each major portion of the work shall be photographed utilizing the same views at the completion of construction.

C. The Contractor shall also inspect and photograph any structure within 300 feet of the limits of the construction prior to beginning of work. Photographs of any existing damaged areas shall be taken.

3.3 TECHNIQUE FOR VIEWS REQUIRED FOR VIDEO RECORDING

A. At the start of production, an identification summary shall be read into the record. This summary shall include (1) tape number, (2) job title, (3) job location, (4) positional location at job start, (5) date and time, (6) weather, and (7) any other notable conditions.

B. Coverage
   1. The recording shall include coverage of all areas located within the construction zone-of-influence. This zone shall be defined as (1) the area within the limits of construction; (2) areas within 300 feet of the limits of construction, and, (3) areas directed by the Owner. The surface features shall include, but not be limited to, all roadways, pavements, curbs, driveways, sidewalks, culverts, headwalls, retaining walls, buildings, landscaping, shrubbery and fences. Of particular concern shall be the existence, or non-existence, of any faults, fractures or defects.
   2. The coverage shall be continuous (i.e., the camera shall not be turned off once photography has begun) to the greatest extent practicably possible. If the camera must be turned off, then a verbal message shall be inserted stating that the camera will be turned off and the reason for discontinuing coverage.

C. Visibility
   1. No recording shall be done during periods of significant precipitation, mist or fog. The recording shall only be done when sufficient sunlight is present to properly illuminate the subjects of recording.

3.4 DELIVERY OF PRINTS

A. After approval of videos, deliver two (2) record copies to Engineer.

B. Preconstruction photographs shall be delivered to the Engineer prior to the beginning of construction.

C. Deliver progress prints to Engineer to accompany related Application for Payment.

3.5 DELIVERY OF VIDEO RECORDINGS

A. Recording Schedule
   1. The recording shall be performed prior to the placement of any construction materials or equipment on the proposed construction site, but not more than four weeks prior to the placement of materials or equipment.

B. Video Indexing
   1. All video recordings and their storage cases shall be properly identified by video recording index number, project title and general project location. Displayed on the storage case of each video recording shall be a log of that recording's contents. That log

shall describe: (1) the various segments contained on that recording in terms of the names and the sides of the streets, (2) coverage start, direction and endpoints, with corresponding video recording file, chapter, or timestamp numbers.

2. A cumulative index correlating the various segments of coverage to their corresponding recordings shall be typed and supplied to the Owner.

C. Unacceptable Documentation

1. The Owner shall have the authority to reject all or any portion of the video recording documentation not conforming to the specifications. Those rejected portions shall be re-recorded at no additional cost to the Owner.

D. Specification Deviations

1. Any deviation from these specifications must have the written approval of the Owner and Engineer.

END OF SECTION 013593

SECTION 014516 - QUALITY CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes requirements of a general nature related to the Contractor's responsibility for quality control involving inspections, tests, certifications, and reports. This Section includes the following:
   1. Inspections.
   2. Quality Assurance – Control of Installation.
   3. References.
   4. Inspecting and Physical Testing Laboratory Services.
   5. Contractor's responsibilities.
   6. Reports.
   7. Equipment Calibration.

B. Unless otherwise indicated on the Attachments or Specifications, only new materials shall be incorporated in the Work. All materials furnished by the Contractor to be incorporated in the Work shall be subject to the inspection and approval of the Owner and the Engineer. No material shall be processed for or delivered to the Work without prior approval by the Engineer.

C. The following Sections are related to this Section:
   1. Section 013300 – Submittal Procedures.

1.2 INSPECTIONS

A. The Engineer and the Owner shall have the right to inspect all material and equipment at all stages of collection and processing and shall be allowed access to the site and to the Contractor's and supplier's facilities to conduct such inspections. Onsite work shall be subject to continuous inspection. Inspection by the Engineer or the Owner shall not release the Contractor from responsibility or liability with respect to material. The Engineer or the Owner will supply the Contractor a minimum of 24 hours' notice prior to unscheduled offsite inspections.

1.3 QUALITY ASSURANCE – CONTROL OF INSTALLATION

A. The Contractor shall monitor quality control over suppliers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. The Contractor shall comply with manufacturers' instructions, including each step in sequence.

C. The Contractor shall examine the areas and conditions where Work is to be performed and notify the Owner of conditions detrimental to the proper and timely completion of the Work. The Contractor shall not proceed with the Work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Owner.

D. The Contractor shall request clarification from Engineer should manufacturers' instructions conflict with Contract Documents. The clarification shall be received prior to proceeding.

E. The Contractor shall comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

F. Work shall be performed by persons qualified to produce workmanship of specified quality.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, the Contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. The Contractor shall be familiar with applicable standards. Copies of these standards shall be obtained by the Contractor where required by product specification sections.

C. The contractual relationship, duties, and responsibilities of the parties in Contract nor those of the Engineer shall not be altered from the Contract Documents by mention or influence otherwise in any reference document.

1.5 INSPECTING AND PHYSICAL TESTING LABORATORY SERVICES

A. The ***Contractor*** shall contract with an independent consultant to perform laboratory testing related to soils and concrete work.

B. The Contractor shall provide labor and materials and necessary testing facilities at the site as required by Specifications and the independent laboratories. The Contractor shall cooperate with the Owner and the Engineer and the independent laboratory and shall provide the Owner with at least 48 hours' notice prior to any concrete pour or soils work.

C. The Contractor shall be solely responsible for the adequate stability of cut soil slopes at the site and for providing a safe working condition within excavated areas.

D. Inspecting, testing, and source quality control may occur on or off the project site. Offsite inspecting or testing shall be performed as required by the Engineer or the Owner.

E. The Contractor shall be responsible for scheduling and coordinating inspections, tests, and similar activities with minimum delay to project.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall provide incidental labor and facilities:
   1. to provide access to Work to be tested,
   2. to obtain and handle samples at the site,
   3. to facilitate tests and inspections,
   4. to provide storage of test samples.

B. The Engineer and Owner shall be notified 48 hours prior to expected time for operations requiring services.

C. The Engineer shall make arrangements with the Contractor and pay for additional samples and tests required for Engineer's use.

D. Testing or inspecting does not relieve Contractor to perform Work to contract requirements.

E. Retesting required because of non-conformance to specified requirements shall be performed by the same independent Consultant firm at the Contractor's expense.

1.7 REPORTS

A. Transcripts of required Certified Test Reports including all test results shall be submitted for review to the Engineer. Acceptance by the Engineer shall be received prior to delivery of material. The testing shall have been performed by an approved independent testing facility within the previous six months of submittal of the reports for review. Transcripts of test results shall be accompanied by a certificate in the form of a letter from the manufacturer or supplier certifying that the tested material meets the specified requirements and is of the same type, quality, manufacturer, and make as that specified.

B. The Contractor may, in lieu of the specified tests and at the option of the Engineer, submit for review a notarized Certificate of Compliance in the form of a letter from the manufacturer. The Certificate shall state the following:
   1. Manufacturer has performed all required tests.
   2. Materials supplied meet all test requirements.
   3. Tests were performed within six months of submittal of the Certificate.
   4. Materials that were tested are the same type, quality, manufacture, and make as those specified.
   5. Include identification of the materials.

C. The independent testing firm shall submit a certified written report, in triplicate, of each inspection and test to the Contractor. One copy of these results will be provided to the Engineer on the same day as the testing is performed.
   1. Submit additional copies of each report to the governing authority, when the authority so directs.
   2. Report Data: Reports of each inspection, test, or similar service include, but are not limited to, the following:
      a. Date of issue.
      b. Project title and number.
      c. Name, address, and telephone number of testing agency.
      d. Dates and locations of samples and tests or inspections.
      e. Names of individuals making the inspection or test.
      f. Designation of the Work and test method.
      g. Identification of product and Specification Section.
      h. Complete inspection of test data.
      i. Test results and an interpretation of test results.
      j. Ambient conditions at the time of sample taking and testing.
      k. Comments or professional opinion on whether inspected or tested Work complies with requirements.

l. Name and signature of laboratory inspector.
m. Recommendations on retesting.

1.8 EQUIPMENT CALIBRATION

A. All field test equipment will be kept under control of the Contractor's testing Subcontractor. The testing Subcontractor will be fully trained in the use of equipment, test procedures, and interpretations of results for each piece of test equipment. A copy of calibration certification will be kept by the testing Subcontractor and supplied to the Engineer.

B. Calibration of nuclear-density gauges shall conform to the frequencies and methods outlined in ASTM D2922 and D3017. Unstable or erratic gauges shall not be used in density testing and shall be immediately removed from the site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 014516

SECTION 014525 – PIPELINE TESTING AND CLEANING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and test and clean all new pipelines installed under this Contract as specified herein, including chlorination of all water lines, all existing pipelines effected by work, and other potable water lines.

1.2 RELATED WORK

A. Buried pipelines are included in Section 339014.

B. Steel pipe is included in Section 400513.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Furnish all necessary equipment and labor for cleaning, testing and chlorinating the pipelines. The procedures and methods shall be approved by the Engineer.

B. Make any taps and furnish all necessary caps, plugs, etc., as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

3.2 CLEANING PIPELINES

A. As pipe laying progresses and at the conclusion of the work thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

3.3 TESTING

A. General
   1. Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests.
   2. Unless otherwise noted, test pressures shall be as specified below:

a. Hydrostatic Test Pressure (Distribution Main, plumbing) – 150 psi
b. Hydrostatic Test Pressure (Other) – 100 psi
c. New pipelines, which are to be connected to existing pipelines, shall be tested by isolating the new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.
d. Chemical Piping – 125 psi.

3. Conduct final acceptance tests on buried piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed.

B. Hydrostatic Leak Tests

1. Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Approved graduated containers.
2	Pressure gauges.
1	Hydraulic force pump approved by the Engineer. Suitable hose and suction pipe as required.

2. Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be of potable water quality and shall be of such quality as to minimize corrosion of the materials in the piping system. Test water shall be acquired from a source as designated by the Engineer.
3. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents.
4. All parts of the piping system shall be subjected to test pressure specified hereinbefore.
5. Piping
   a. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 4 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 2 days.
   b. When testing cement-mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.
   c. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.
6. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

In this formula:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested in feet.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during the leakage test, in pounds per square inch.

7. The Contractor shall correct any leakage greater than the allowance determined under this formula at no additional cost to the Owner.

C. Initial Service Leak Tests
1. Equipment used for initial service leak testing may be the same as that specified under HYDROSTATIC LEAK TESTS hereinbefore, or the pump connected to the piping system.
2. The initial system leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at no additional cost.

D. Test Records
1. Records shall be made of each piping system installation during the test. These records shall include:
a. Date of test.
b. Description and identification of piping tested.
c. Test fluid.
d. Test pressure.
e. Remarks, to include such items as:
1) Leaks (type, location).
2) Repairs made on leaks.
f. Certification by Contractor and initialed acknowledgement by the Engineer.

3.4 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and fillings, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.5 CHLORINATION OF PIPELINE

A. Piping shall be cleaned and disinfected in compliance with all applicable sections of AWWA Standard C-651. All interior surfaces of pipelines shall be exposed to a 50 PPM free chorine solution for a minimum of 24 hours, after which the lines can be cleaned and flushed provided a 25 PPM free chlorine residual is maintained after the 24 hour period. The lines shall be flushed clean until the chlorine concentration in the water leaving the lines is 1-2 PPM. Chlorine solution with a higher residual may remain in the line, without flushing, if approved by the Engineer.

B. During installation, the interior of all pipe, fittings and other accessories shall be kept as free as possible from dirt and foreign matter at all times. If, in the opinion of the Engineer, the pipe contains dirt or foreign matter that could not be removed during the flushing operation, the interior of the pipe will be cleaned and swabbed with a chlorine solution. When pipe laying is not in progress, the open ends of pipe shall be sealed with watertight plugs.

C. After the completion of hydrostatic pressure tests and prior to disinfection, the pipeline shall be flushed, as thoroughly as possible with the water pressure and outlets available. If feasible, flushing rate should develop a velocity in the pipeline of at least 2.5 fps. Since it is usually difficult to secure this minimum velocity in pipelines over 16 in. in diameter, the requirements of Paragraph 3.02 A above shall be rigidly enforced for the larger sizes of pipe. The minimum quantity of water used for flushing shall be in excess of the storage capacity of the pipeline, to ensure that clean water has traversed the entire length of the line.

D. After flushing has been completed to the point that all apparent dirt and foreign matter have been removed from the pipeline, either liquid chlorine or calcium hypochlorite solution shall be injected into the pipeline as provided in AWWA Standard C-651.

E. Following chlorination, all treated water shall be flushed from the newly laid pipeline at its extremities until the replacement water throughout its length is proved by test to be: a) comparable in quality to the water served the public from the existing water supply system, or b) as approved by the Engineer. The satisfactory quality of water delivered by the new pipeline shall continue for a period of at least two days. Samples will be taken from a tap located and installed in such a way as to prevent outside contamination. Should the initial treatment fail to achieve the satisfactory quality described above, the original chlorination procedure shall be repeated until satisfactory results are obtained. All sampling and testing will be performed by Flint Water Treatment Plant personnel.

F. When connecting new piping to existing piping, the Contractor shall disinfect all new and impacted existing piping to the nearest practical isolation valve.

G. Special disinfecting procedures may be developed with the Engineer and Owner where the method outlined above is not practical.

H. All potable water piping as part of the plumbing systems shall be disinfected per State of Michigan requirements. Disinfection of the potable water system must include the following:
   1. The pipe system must be flushed with clean, potable water until no dirty water appears at the points of outlet;
   2. The system must then be filled with a water chlorine solution containing at least 50 parts per million of chlorine and allowed to stand for 24 hours; or a solution containing at least 200 parts per million of chlorine and allowed to stand for three hours; and
   3. Following the allowed standing time the system must be flushed with clean potable water until no chlorine remains.

3.6 DISPOSAL OF CHLORINATED WATER

A. The Contractor will not be permitted to discharge chlorinated or dechlorinated water to the sanitary sewer system. The Contractor shall be responsible for treatment and disposal of chlorinated water in accordance with all Local, State, and Federal Regulations. The Contractor

shall be responsible for obtaining all discharge permits as required for legal disposal of water generated from the disinfection process as provided in AWWA Standard C655.

END OF SECTION 014525

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SECTION 014526 – TIGHTNESS TESTING OF LIQUID RETAINING STRUCTURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and perform tightness testing of cast in place reinforced concrete liquid retaining structures listed herein and all retesting until the structures meet the requirements specified herein.

1.2 RELATED WORK

A. Control of Work is included in 013213.

B. Concrete joints and joint accessories are included in Section 031500.

C. Cast in place concrete is included in Section 033000.

D. Waterproofing and dampproofing are included in Division 07.

E. Watertight access doors are included in Section 083919.

F. Slide gates and weir gates are included in Section 352017.

G. Valves are included in Section 400550.

1.3 SUBMITTALS

A. Submit for each structure, in accordance with Section 013300, a detailed plan and schedule which shows the method of filling and disposal of water.

B. Submit, in accordance with Section 013300, a completed Tightness Test Report (Figure A, appended at the end of this Section) of each test for each structure.

1.4 REFERENCE STANDARDS

A. American Concrete Institute (ACI)
   1. ACI 350.1-01 - Tightness Testing of Environmental Engineering Concrete Structures and Commentary.

B. Where reference is made to the above standard, the revision in effect at the time of bid opening shall apply.

1.5 PROJECT / SITE REQUIREMENTS

A. Coordinate timing and procedures for obtaining water for testing, structure testing, and water disposal with the Owner a minimum of 30 days in advance of the actual testing.

B. Water Source and Disposal
   1. Water for testing shall be provided per specification section 01 32 13 paragraph 1.10.
   2. Water for testing shall be plant process water. Water shall be obtained at a time, rate of flow and location approved by the Owner. All labor, materials, equipment, incidentals and power required to convey the water to the structure shall be provided by the Contractor.
   3. Test water shall be disposed of by the Contractor in an approved manner including dechlorination. Provide a plan for dechlorination for review by the Engineer. Water shall not be disposed of by discharging it onto the ground surface of public or private land.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The tightness testing of cast in place reinforced concrete liquid retaining structures shall conform to ACI 350.1-01 and as specified herein.

B. Perform tightness tests prior to waterproofing and dampproofing and prior to placing backfill around the structure in order to permit observation and detection of leakage points.

C. Each cell of multi-cell tanks shall be tested individually.

3.2 PREPARATION

A. Remove all dirt, mud and debris from the structure prior to initiating tightness tests. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.

B. Inlet and outlet pipes not required to be operational for the tests shall be temporarily sealed or bulkheaded prior to testing.

C. Confirm that all valves, slide gates, and watertight access doors are completely closed. Repair and reset seals if necessary. All valves, slide gates, and watertight access doors shall be tested for leakage in accordance with the requirements of the respective Sections as part of the preparation for final tightness testing under this Section. Estimates of gate or valve leakage will not be allowed as adjustments to the measured structure leakage.

3.3 EXAMINATION

A. Inspect the structure to be tested for potential leakage paths including cracks, voids, honeycombs, and unsealed joints and repair such paths as directed by the Engineer, at no additional cost to the Owner.

3.4 TESTING PROCEDURES

A. Condition of Testing
   1. Do not begin filling of reinforced concrete structure until all concrete elements of the structure have attained the specified design strength, but not less than 14 days after all concrete elements have been placed.
   2. Filling of reinforced concrete structure shall not exceed a rate of 4-ft in 24 hours.
   3. Fill reinforced concrete structure to the maximum operating water surface level and maintain the water at that level for at least 72 hours prior to beginning tightness tests to minimize water absorption by the concrete during testing.
   4. Test only a single structure at a time. Concurrent testing of contiguous or adjacent structures will not be allowed. For the purpose of tightness testing a single structure is any tank, wet well, basin, cell, compartment, filter, channel or similar construction which may be isolated by gates, valves, stop logs or the like such that it may be full of liquid when adjacent construction is empty.

B. Testing Procedures
   1. Duration of the test shall not be less than the time required to produce a drop in the water surface of 1/2-in based on the calculated maximum allowable leakage rate or 3 days, whichever is greater.
   2. Measure water surface elevations at 24 hour intervals. Measure water surface elevations at the same four locations 90 degrees apart. Record water temperature 18-in below the water surface when taking the first and last sets of measurements. The methods used to determine the amount of precipitation or evaporation shall be approved by the Engineer.
   3. The percentage of water volume loss shall be computed based on the measured change in water surface elevation, the area of the horizontal water surface, the initial water volume and any correction for precipitation or evaporation where applicable.

C. The Existing Filter Cells No. 1-20 and shall be individually tested by observation only for the conditions listed in Paragraph 3.05 A and shall be completed after full completion of modifications for each Filter Cell.

D. Reports
   1. Notify the Engineer and Owner of the scheduling of tests 30 working days prior to the tests. The Engineer may monitor any tightness testing performed on the structures.
   2. Submit a completed Tightness Test Report on the form appended to this Section for each structure tested.

3.5 ACCEPTANCE

A. The following conditions shall be considered as NOT meeting the criteria for acceptance regardless of the actual loss of water volume from the structure.

1. Groundwater seeping or flowing into the structure through floors, walls, or wall-floor joints.
2. Structures which exhibit seeping or flowing water from joints, cracks, voids, honeycombs, or from beneath the foundation.
3. Increased flow from underdrain system during tightness testing.
4. Damp spots on concrete surfaces.
5. Moisture can be deposited on a dry hand held against the exterior surface of the structure.

B. The tightness of concrete tanks and structures shall be considered acceptable when the conditions of Paragraph 3.05 A are not present and when loss of water volume is within the criteria listed below:
1. For unlined (or partially lined) reinforced concrete tanks, loss of volume not exceeding 0.10 percent in 24 hours (HST-100).
2. For reinforced concrete tanks with fully lined walls, loss of volume not exceeding 0.05 percent in 24 hours (HST-050).
3. For completely lined tanks, no measurable loss of volume (HST-NML).

3.6 REPAIRS AND RETESTING

A. Structures failing the tightness test and not exhibiting visible leakage may be retested after an additional stabilization period of 7 days. Structures failing this second test shall be repaired at no additional cost to the Owner prior to further testing.

B. Repaired structures shall be retested. Repairs and retesting shall be conducted at no additional cost to the Owner and shall be continued and repeated until the structure meets all requirements specified herein.

3.7 SCHEDULE

A. The following structures shall be tested for tightness:
1. Backwash Recovery System Tanks and Wetwells.
2. Modified Existing Filter Boxes 1 – 20.
3. East Spent Filter Backwash Discharge Structure.
4. West Spent Filter Backwash Discharge Structure.
5. East Contact Tank and tie-ins
6. West Contact Tank and tie-ins.

END OF SECTION 014526

SECTION 014540 – DISINFECTION OF POTABLE WATER FACILITIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, tools, equipment and related items required to disinfect the following potable water facilities:
   1. Filtered Water Conduit
   2. Filters
   3. Contact Tanks.
   4. Backwash Supply Tank
   5. Backwash Recovery System

PART 2 - PRODUCTS

2.1 CHLORINE

A. Liquid chlorine shall meet the requirements of AWWA B301.

B. Calcium hypochlorite shall meet the requirements of AWWA B300.

PART 3 - EXECUTION

3.1 PROCEDURES

A. Prior to initiating disinfection procedures, the Contractor shall confirm that any equipment installed in the space to be disinfected is suitable to be disinfected via the procedures described below.

B. Any tools to be used in the work after the disinfection process has been completed shall be disinfected in accordance with AWWA C-653 prior to use.

C. The Contractor shall provide a disinfection plan for review by the Engineer one month prior to the anticipated date of disinfection.
   1. Should the samples fail to be acceptable, the Contractor shall be obligated to again disinfect the area completely, and have additional samples taken for analysis.
   2. The Contractor shall notify the Owner at least 48-hours prior to the chlorination of the system and shall provide the necessary apparatus, material, supplies, and labor for conducting the tests.
   3. The Contractor shall ensure that the water is disposed of in a manner such that no chlorinated water enters the storm or sanitary sewer systems. Water shall be disposed in accordance with AWWA C-655. Dechlorination shall be provided by the Contractor if deemed necessary.

D. Disinfection of Filtered Water Conduit, Contact Tanks, and Backwash Recovery System
   1. After all work has been completed in the area to be disinfected and the area has been cleaned in a manner acceptable to the Engineer and all construction debris removed, disinfection may commence.
   2. Disinfection shall be performed in accordance with AWWA C653 – Disinfection of Water Treatment Plants. Disinfection shall be accomplished by completely filling the chamber such that the water level is a minimum of 6-inches above the ceiling while simultaneously adding sufficient disinfectant (chlorine solution or sodium hypochlorite) to the incoming water to maintain a level of 50 mg/L of free chlorine in the chamber. The water level shall be maintained for at least 24 hours.
   3. Upon completion of disinfection, the contents of the area shall be pumped to waste, after which the chamber shall be filled with treated water and put into normal service. Water used for disinfection shall be disposed of in accordance with AWWA C-655.

E. Filters
   1. After all work has been completed in the filter to be disinfected and the filter has been cleaned in a manner acceptable to the Engineer and all construction debris removed, the filter shall be disinfected.
   2. After placement of the sand, the entire depth of sand and underdrain system in each filter shall be disinfected. Only products approved for disinfection of potable water shall be used. Filter disinfection shall be in accordance with the following procedure except as otherwise required by AWWA C-653:
      a. With all other filter valves closed, the filter shall be filled with water from the backwash system while simultaneously adding sufficient disinfectant (chlorine solution or sodium hypochlorite) to the incoming water to produce a concentration of at least 50 mg/L of free chlorine in the filter box.
      b. The backwash valve shall then be closed, and the disinfectant allowed to remain in the filter box. The water level shall be maintained at an elevation four inches below the top of the filter walkways. The free chlorine residual shall be verified to be at least 25 mg/L in the filter after 24 hours or the filter shall be backwashed, and the disinfection procedure shall be repeated. The backwash water shall be disposed of in accordance with applicable regulations.
      c. Upon completion the chloramine residual should be equal to finished water residual of disinfection, the filter contents shall be backwashed to waste to remove all traces of the disinfectant solution. Backwash water shall be disposed of in accordance with applicable regulations. After at least one 30-minute backwash, the filter shall be drained and GAC media placed in accordance with the previous section.
   3. Water for backwashing shall be supplied by the Owner via the backwash supply tank. Water for backwashing shall meet potable water regulations.
      a. Backwash water obtained from the backwash supply tank, Contractor shall coordinate time and usage with the Owner so as not to interfere with Owner's operations.
      b. If the chloramine residual in the backwash tank falls below 2.5 mg/L, the tank shall be drained and refilled prior to use.

F. Backwash Supply Tank
   1. If the total chlorine residual in the backwash supply tank falls below 1.0 mg/L, the Contractor shall disinfect the backwash supply tank. Disinfection shall be done as described in AWWA C652. The contractor shall furnish the chlorine and perform the

disinfection, all of which shall be done in the presence of the Owner. Water for testing shall be provided by the City of Minneapolis.

G. Contact Tank, Backwash Supply Tank, Filtered Water Conduit, Backwash Recovery System – Alternate Method.
   1. After all work has been completed in a chamber and the chamber has been cleaned in a manner acceptable to the Engineer and all construction debris removed, the chamber may be disinfected.
   2. The disinfection method shall conform to AWWA C-652, "Disinfection of Water Storage Facilities", latest edition. Disinfection shall be accomplished by applying a solution of 200 mg/L available chlorine to all surface of all parts of the chamber that may be in contact with water when the chamber is full to the overflow elevation.
   3. The chlorine solution may be applied with suitable brushes or spray equipment. The solution shall thoroughly coat all surfaces to be treated, including existing piping, valves, suction hoods, columns, walls, floors, etc.
   4. The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30 minutes, at which time potable water may be admitted to the chamber.

3.2 TESTING

A. After the chlorination procedure is completed and before the area is placed into service, the water from the area in question shall be sampled and tested in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater. Testing shall include coliform organisms and tastes and odors in accordance with AWWA C-652.

B. A minimum of six samples shall be taken and tested for coliform organisms while a minimum of three are required for taste and odor. Sample locations and depths shall be determined by the Engineer. All six coliform samples must test negative prior to placing that affected portion of the area in service. If any test shows the presence of coliform bacteria, a repeat six samples shall be taken until all samples are negative or the affected portion of the area shall again be subjected to disinfection at no additional costs if required by the Engineer.

C. All sampling and testing will be performed by the Owner.

END OF SECTION 014540

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SECTION 015100 – TEMPORARY FACILITIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, equipment, materials, and incidentals necessary and provide separate temporary facilities for the Contractor's use, as specified herein and as shown on the drawings.

B. Operate and maintain temporary facilities for the duration of the project and as directed by the Engineer. All cost and use charges for temporary facilities shall be included in the Contract Price.

1.2 RELATED WORK

A. Control of Work is included in Section 013213.

1.3 SUBMITTALS

A. Submit shop drawings and product data, in accordance with Section 01 33 00 showing materials of construction and details of installation for:
   1. Site Plan: Show the proposed locations for temporary facilities including offices, temporary utilities, storage containers/buildings, vehicle access and parking areas, temporary power requirements, material laydown and staging areas, temporary fencing, and other security measures.
   2. Temporary Fence: Layout drawings which indicate dimensions, access to fire hydrants, gate locations and opening sizes, and other site specific requirements.
   3. Project Sign: Layout, graphics, and wording.

B. Submittals shall be received by the Engineer no later than the date of the Preconstruction Meeting.

1.4 QUALITY ASSURANCE

A. Temporary facilities shall comply with all applicable state and local ordinances, codes and regulations.

B. Coordinate with authorities having jurisdiction to inspect (and test if required) temporary facilities.

C. Obtain all required permits for temporary facilities.

1.5 DEFINITIONS

A. Duration of the project: The period of time from the date of the Notice to Proceed to the date of Final Completion, inclusive.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Temporary Fence: Fabric shall be No. 9 gauge galvanized wire woven in 2-in diamond mesh with top and bottom twisted selvage. Intermediate and terminal posts shall be galvanized steel H or pipe, minimum 2-3/8-in OD line posts, 2-7/8-in OD corner and pull posts, and 1-5/8-in OD top rails.

B. Project Sign: Plywood shall be A-A EXT-APA grade, 1-in thick. Posts and braces shall be pressure treated lumber.

2.2 EQUIPMENT

A. Fire Extinguishers: Provide portable, UL-rated with class and extinguishing agent required by locations and classes of fire exposure.

B. Temporary Heat: Provide vented, self-contained, liquid propane gas or fuel oil heaters with individual space thermostatic control. Equipment shall be listed and labeled for type of fuel consumed and marked for intended use.

C. Printer: Provide a printer, ink and paper for the Resident Engineer’s exclusive use throughout the project. Printer shall be an HP Officejet 7612 printer or equal and be capable of both color copying, printing and scanning at sheet sizes up to 11 x 17. Provide three reams (500 sheets) of 8.5 x 11 paper, one ream of 11 x 17 paper, and one set of color and black ink per month.

D. Portable Hard Drive: Provide the Resident Engineer with a 500 GB minimum capacity USB-connectable portable hard drive.

PART 3 - EXECUTION

3.1 TEMPORARY POWER AND LIGHT

A. The Contractor may be allowed to use plant power without charge for construction purposes.

B. The Contractor shall provide a summary of the temporary electrical requirements prior to the notice to proceed.

C. The Owner will provide power from Control Station No. 2. The Contractor will be responsible for installing all temporary power needs from this location for all construction trailers and other power needs.

D. The express approval of the Owner shall be obtained before power is used. Use of power for functions not related to construction shall be sufficient cause for withdrawing the privilege of unrestricted use.

E. Contractor shall temporarily suspend power consumption if the power company requests the plant maintains operation under a temporary predetermined demand limit period.

F. Provide properly configured NEMA polarized outlets to prevent insertion of 110-120 Volt plugs into higher voltage outlets. For connection of power tools and equipment, provide outlets equipped with ground-fault circuit interrupters, reset button and pilot light.

G. Provide grounded extension cords. Use heavy duty cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if more than one length is required.

H. Provide general service incandescent lamps as required for adequate illumination. Provide guard cages or tempered glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

3.2 TEMPORARY HEAT

A. Provide heat as may be necessary for thawing out and heating the ground or materials and for proper execution, protection and drying-out of the Work.

3.3 WEATHER PROTECTION

A. Contractor shall furnish, install and maintain temporary heat and enclosures to provide adequate working areas for personnel during the cold weather months.

B. The General Contractor shall furnish temporary heating units (UL or FM listed) to maintain reasonable temperatures within temporary enclosures.

3.4 TEMPORARY AIR AND WATER

A. Contractor shall provide air, and water for testing pipelines and equipment installed by them. Remove temporary piping and appurtenance on completion of testing.

B. The Contractor may be allowed to use plant water without charge for construction purposes.

C. The Contractor shall provide a summary of the temporary water requirements prior to the notice to proceed.

D. The express approval of the Owner shall be obtained before water is used. Use of water for functions not related to construction shall be sufficient cause for withdrawing the privilege of unrestricted use.

3.5 SANITARY FACILITIES

A. Provide self-contained, single occupant toilet units of the chemical, aerated recirculation, or combustion type, properly vented and fully enclosed in a fiberglass or other approved non-absorbent shell.

B. Contractor shall be responsible for maintaining sanitary facilities.

3.6 CONSTRUCTION AIDS

A. Provide temporary elevators, hoists, cranes, scaffolding and platforms as necessary to perform the Work. Provide temporary stairs where ladders are not adequate. Protect permanent stairs from damage from construction operations.

3.7 VEHICLE ACCESS AND PARKING

A. Provide temporary access roads, parking areas, traffic control devices and staging areas as approved by the Engineer and Owner.

B. Provide minimum 12-ft by 24-ft by 6-in deep dense graded crushed stone or paved parking area adjacent to the field office for exclusive use by the Contractor and Engineer for the duration of the project.

C. Clear snow and ice from all drives, walks, and stairs to maintain safe vehicle and pedestrian access to the site and facilities as directed by the Engineer.

3.8 WASTE MANAGEMENT

A. Provide covered dumpster, minimum 4-cubic yards, dedicated for field office waste. Provide separate covered dumpster of adequate size for construction debris. Empty dumpsters on a regular basis and as directed by the Engineer. Dumpsters shall not exceed their capacities at any time.

3.9 REMOVAL AND RESTORATION

A. Remove each temporary facility complete when need for its service has ended and as approved by the Engineer. Coordinate removal of temporary facilities with authorities having jurisdiction.

B. Restore all improvements damaged by the installation, operation, and removal of the temporary facilities. Obtain prior approval from Owner and Engineer for restoration work.

C. Contractor shall construct temporary fencing to maintain a boundary around the construction project. Contractor shall not modify or remove any Water Treatment Plant perimeter fencing.

END OF SECTION 015100

SECTION 015713 – ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment and perform all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Section, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.

B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.

C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as diversion channels, sedimentation or filtration systems, berms, staked hay bales, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to construction activity in that area.

D. This Section is intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the Contractor’s responsibility to determine the specific construction techniques to meet these guidelines.

E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the State of Michigan. Prepare sedimentation and erosion control drawings meeting the requirements for approval by that agency. Upon approval, furnish two copies of the approved Drawing to the Engineer.

1.2 APPLICABLE REGULATIONS

A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

1.3 NOTIFICATIONS

A. The Engineer will notify the Contractor in writing of any non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the Contractor in writing, through the Engineer, of any non-compliance with State or local requirements. After receipt of such notice from the Engineer or from the regulatory agency through the Engineer, immediately take corrective action. Such

notice, when delivered to the Contractor or his authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the Contractor fails or refuses to comply promptly, the Owner may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor unless it is later determined that the Contractor was in compliance.

1.4 IMPLEMENTATION

A. Prior to commencement of the work, meet with the Engineer to develop mutual understandings relative to compliance with these provisions and administration of the environmental pollution control program.

B. Remove temporary environmental control features, when approved by the Engineer and incorporate permanent control features into the project at the earliest practicable time.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EROSION CONTROL

A. Provide positive means of erosion control such as shallow ditches around construction to carry off surface water. Erosion control measures, such as siltation basins, hay check dams, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Offsite surface water shall be diverted around the site, to a downstream channel ahead of siltation barriers. Flow of surface water into excavated areas shall be prevented. Ditches around construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled and the ground surface restored to original condition.

3.2 PROTECTION OF SURFACE WATERS

A. Take all precautions to prevent, or reduce to a minimum, any damage to any surface water from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Divert such waters through a settling basin or filter before being directed into streams or surface waters.

B. Do not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water to allowable levels.

C. Take all preventative measures to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with a

contingency action approved by the State of Michigan. Submit two copies of approved contingency plan to the Engineer.

3.3 PROTECTION OF LAND RESOURCES

A. Restore land resources within the project boundaries and outside the limits of permanent work to a condition, after completion of construction that will appear to be natural and not detract from the appearance of the project. Confine all construction activities to areas shown on the Drawings.

B. Outside of areas requiring earthwork for the construction of the new facilities, do not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the Engineers. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The Contractor shall in any event be responsible for any damage resulting from such use.

C. Before beginning operations near them, protect trees that may possibly be defaced, bruised, injured, or otherwise damaged by the construction equipment, dumping or other operations, by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly.

D. Any trees or other landscape features scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to their original condition. The Engineer will decide the method of restoration to be used and whether damaged trees shall be treated and healed or removed and disposed of.
   1. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1-inch in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.
   2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the Contractor and are beyond saving in the opinion of the Engineer, shall be immediately removed and replaced.

E. The locations of the Contractor's storage and other construction buildings required temporarily in the performance of the work, shall be cleared portions of the job site or areas to be cleared as shown on the Drawings and approved by the Engineer and shall not be within wetlands or floodplains. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings. Drawings showing storage facilities shall be submitted for approval of the Engineer.

F. All debris and excess material will be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.4 PROTECTION OF AIR QUALITY

A. Burning – The use of burning at the project site for the disposal of refuse and debris will not be permitted.

B. Dust Control – Maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded and which would cause a hazard or nuisance to others.

C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the Engineer.

D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor shall have sufficient competent equipment on the job to accomplish this. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the Engineer.

3.5 NOISE CONTROL

A. Make every effort to minimize noises caused by the construction operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with Federal and State regulations.

3.6 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

A. Maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

END OF SECTION 015713

SECTION 015726 – DUST CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Perform dust control operations, in an approved manner, whenever necessary or when directed by the Engineer, even though other work on the project may be suspended. Dust control shall be generally accomplished by the use of water; however, the use of calcium chloride may be used when approved and when necessary to control dust nuisance.

B. Calcium chloride shall conform to AASHTO M144, Type I except the requirements for "total alkali chlorides" and other impurities shall not apply.

C. Methods of controlling dust shall meet all air pollutant standards as set forth by Federal and State regulatory agencies.

D. The Contractor shall take additional measures as required to minimize migration of construction related dust from the active construction areas into the office areas occupied by the Owner during construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 015726

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SECTION 016600 – DELIVERY, STORAGE, AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.2 TRANSPORTATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's instructions.

B. Schedule delivery to reduce long-term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.

D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.

E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

F. Provide necessary equipment and personnel to unload all items delivered to the site.

G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct and items are undamaged. For items furnished by others (i.e., Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.

H. If any item has been damaged, such damage shall be repaired at no additional cost to the Owner.

I. Delivery security procedures shall conform to the requirements of Section 013213.

1.3 STORAGE AND PROTECTION

A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him/her. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.

B. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer.
   1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.
   2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.
   3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
   4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

C. All paint and other coating products shall be stored in areas protected from the weather. Follow all storage requirements set forth by the paint and coating manufacturers.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

END OF SECTION 016600

SECTION 016650 – EQUIPMENT TESTING AND STARTUP

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide a competent field services technician of the manufacturers of all equipment furnished under Divisions 21-Fire Suppression, 22-Plumbing, 23-Heating, Ventilating and Air Conditioning, 26-Electrical, 27-Communications, 28-Electroinic Safety and Security, 40-Process Integration, 43-Process Gas and Liquid Handling, Purification and Storage Equipment, and 46-Water and Wastewater Equipment to supervise installation, adjustment, initial operation and testing, performance testing, final acceptance testing and startup of the equipment.

B. Perform specified equipment field performance tests, final acceptance tests and startup services.

1.2 RELATED WORK

A. Operation and Maintenance Data is included in Section 017823.

B. Performance and acceptance testing, and startup requirements are included in the respective sections of Divisions 21 22, 23, 26, 27, 28, 40, 43 and 46.

1.3 SUBMITTALS

A. Submit name, address and resume of proposed field services technicians at least 30 days in advance of the need for such services.

B. Submit to Engineer and Owner for review in accordance with Section 013300 – Submittals, detailed testing procedures and plans for shop tests, functionality tests and performance tests as specified in the various equipment specification sections. Test procedures and plans shall be submitted at least 30 days in advance of the proposed test dates and shall include at least the following information:
   1. Name of equipment to be tested, including reference to specifications section number and title.
   2. Testing schedule of proposed dates and times for testing.
   3. Summary of power, lighting, chemical, water, gas, etc., needs and identification of who will provide them.
   4. Outline specific assignment of the responsibilities of the Contractor and manufacturers' factory representatives or field service personnel.
   5. Detailed description of step-by-step testing requirements, with reference to appropriate standardized testing procedures and laboratory analyses by established technical organizations (e.g., ASTM, WEF Standard Methods, etc.).

C. Samples of forms to be used to collect and record test data and to present tabulated test results shall be submitted to the Engineering for review. Submit in accordance with Section 013300 copies of test reports upon completion of specified shop, performance and acceptance tests. Test

reports shall incorporate the information provided in the test procedures submittals, modified to reflect actual conduct of the tests and the following additional information:

1. Copy of all test data sheets and results of lab analyses.
2. Summary comparison of specified test and performance requirements versus actual test results.
3. Should actual test results fail to meet specified test and performance requirements, describe action to be taken prior to re-testing equipment.

D. Submit in accordance with Section 013300 copies of the manufacturer's field service technician's report summarizing the results of his/her initial inspection, operation, adjustment and pre-tests. The report shall include detailed descriptions and tabulations of the points inspected, tests and adjustments made, quantitative results obtained, suggestions for precautions to be taken to ensure proper maintenance, and the equipment supplier's Certificate of Installation in the format specified hereinafter.

1.4 QUALITY ASSURANCE

A. Field service technicians shall be competent and experienced in the proper installation, adjustment, operation, testing and startup of the equipment and systems being installed.

B. Manufacturers' sales and marketing personnel will not be accepted as field service technicians.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRELIMINARY REQUIREMENTS

A. After installation of the equipment has been completed and the equipment is presumably ready for operation, before it is operated by others, the manufacturer's field service technician shall inspect, operate, test and adjust the equipment.

B. The inspection shall include at least the following points where applicable:

1. Soundness (without cracks or otherwise damaged parts).
2. Completeness in all details, as specified and required.
3. Correctness of setting, alignment and relative arrangement of various parts.
4. Adequacy and correctness of packing, sealing and lubricants.

C. The operation, testing and adjustment shall be as required to prove that the equipment has been left in proper condition for satisfactory operation under the conditions specified.

D. Upon completion of this work, the manufacturer's field service technician shall submit a signed report of the results of his/her inspection, operation, adjustments and tests.

3.2 WITNESS REQUIREMENTS

A. Shop tests or factory tests may be witnessed by the Owner and/or Owner's representatives, as required by the various equipment specifications.

B. Functionality and performance tests shall be performed in the presence of the Owner, the Owner's designed personnel and/or Owner's representatives.

3.3 FUNCTIONALITY AND PERFORMANCE TESTING OF THE TREATMENT PLANT AND RELATED SYSTEMS

A. General Requirements
1. Successfully execute the step-by-step procedure of startup and performance demonstration specified hereinafter.
2. The functionality and performance demonstration shall be successfully executed prior to acceptance by the Owner of the treatment plant and its related systems.
3. All performance tests and inspections shall be scheduled at least five working days in advance or as otherwise specified with the Owner and the Engineer.
4. All performance tests and inspections shall be conducted during the work week of Monday through Friday, unless otherwise specified.

B. Preparation for Functionality Testing
1. All mechanical and electrical equipment shall be checked to ensure that it is in good working order and properly connected. Preliminary run-ins of the various pumps and other equipment shall be made. All systems shall be cleaned and purged as required. All sumps, tanks, pumps and pipelines which are hydraulically checked shall be drained and returned to their original condition once the water testing is complete.
2. All instruments and controls shall be calibrated through their full range. All other adjustments required for proper operation of all instrumentation and control equipment shall be made.
3. Perform all other tasks needed for preparing and conditioning the treatment facilities for proper operation.
4. No testing or equipment operation shall take place until the Contractor verifies for the Engineer that all specified equipment has been installed and is in good working order.
5. No testing or equipment operation shall take place until it has been verified by the Engineer that all lubricants, tools, maintenance equipment, spare parts and approved equipment operation and maintenance manuals have been furnished as specified.

C. Facilities Performance Testing
1. Test period shall not begin until all new treatment facilities and equipment have been tested as specified and are ready for operation. The Owner shall receive spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction prior to the startup with water. All valve tagging shall also be complete prior to this startup. Submit a Performance Testing Plan 30 days in advance of the proposed testing date for review.
2. Demonstrate a 30 consecutive 24-hour day period of successful operation of the facility as a prerequisite of Acceptance.
3. In the event of failure to demonstrate satisfactory performance of the facility on the first or any subsequent attempt, all necessary alterations, adjustments, repairs and replacements shall be made. The Contractor will be allowed 4 hours to make a repair or

re-start the test from the time the failure or malfunction is reported. If the repair exceeds 4 hours a new test period shall begin. When the facility is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the facility has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.

4. The Owner will furnish all operating personnel (other than vendor's or subcontractor's service personnel) needed to operate equipment during the final test period; however, said personnel will perform their duties under Contractor’s direct supervision. Until performance tests are completed and units and systems are accepted by the Owner as substantially complete, the Contractor shall be fully responsible for the operation and maintenance of all new facilities.
5. The Owner will provide all necessary chemicals and electricity. However, the Contractor shall provide all necessary personnel of the various construction trades, i.e., electricians, plumbers, etc., and field service personnel of the major equipment suppliers on an eight hour per day basis at the facilities and on a 24 hour per day basis locally during the startup period.
6. Do not, at any time, during performance testing allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

END OF SECTION 016650

EQUIPMENT SUPPLIER'S CERTIFICATE OF INSTALLATION

Owner
Project Contract No.

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I, _____, Authorized representative of _____
(Print Name) (Print Manufacturer's Name)

hereby CERTIFY that _____
(print equipment name and model with serial number)

installed for the subject project has (have) been installed in a satisfactory manner, has (have) been tested and adjusted, and is (are) ready for final acceptance testing and operation on:

Date _____

Time _____

CERTIFIED BY: _____
(Signature of Manufacturer's Representative)

Date: _____

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SECTION 017329 – CUTTING, CORING, AND PATCHING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section covers the cutting, coring, rough and finished patching of holes and openings Holes and opening maybe in existing construction, or in parts of new construction. Procedures for cutting and patching will be the same for either condition.

B. All cutting, coring, and rough patching shall be performed by the Contractor. Finish patching shall be the responsibility of the Contractor and shall be performed by the trade associated with the application of the particular finish.

C. Provide all cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:
   1. Make its several parts fit together properly.
   2. Uncover portions of the work to provide for installation of ill-timed or improperly scheduled work.
   3. Remove and replace defective work.
   4. Remove and replace work not conforming to requirements of Contract Documents.
   5. Remove samples of installed work as specified for testing.
   6. Provide penetrations of structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit.
   7. Provide penetrations of non-structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit. The determination of what is a nonstructural surface or material shall be made by the Engineer.
   8. Remove, install, or relocate materials or equipment.

1.2 RELATED WORK

A. Summary of Work is included in Section 011100.

B. Concrete is included in Division 3.

1.3 SUBMITTALS

A. Submit, in accordance with Section 013300, a written request prior to executing any cutting or alteration which is not shown or detailed on the contract documents which affects or requires:
   1. Cutting structural members.
   2. Holes drilled in beams or other structural members.
   3. Work of the Owner or any separate contractor.
   4. Structural value or integrity of any element of the project.
   5. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
   6. Efficiency, operational life, maintenance or safety of operational elements.
   7. Visual qualities of sight-exposed elements.

B. Request shall include:
   1. Identification of the project.
   2. Description of affected work.
   3. The reason for cutting, alteration or excavation.
   4. Effect on work of Owner or any separate contractor, or on structural or weatherproof integrity of project.
   5. Description of proposed work:
      a. Method and extent of cutting, patching, alteration, or excavation.
      b. Trades who will execute the work.
      c. Products proposed to be used.
      d. Extent of refinishing to be done.
   6. Alternatives to cutting and patching.
   7. If the work is considered out of scope, provide a cost proposal.
   8. Confirmation of coordination with any separate contractor whose work will be affected.
   9. Related shutdown requests if required to do the work.
   10. Request for hot work permit if required to do the work.

C. Submit written notice to the Engineer designating the date and the time the work will be uncovered.

D. When a written request is required, do not proceed with the work until a written notice to proceed is received from the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with specifications and standards for each specific product involved. Where there is no equivalent specification, the Contractor shall notify the Engineer who will provide a specification for the materials to be used.

B. Concrete and grout for rough patching shall be as specified in Divisions 3 and 4.

C. Materials for finish patching shall be equal to those of adjacent construction. Where existing materials are no longer available, use materials with equivalent properties and that will provide the same appearance. The materials are to be approved by the Engineer prior to their use.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect existing conditions of project, including elements subject to damage or to movement during cutting and patching.

B. After uncovering work, inspect conditions affecting installation of products, or performance of work.

C. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with work until the Engineer has provided further instructions.

3.2 PREPARATION

A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.

B. Protect surrounding materials and equipment prior to starting work.

C. Contain and control cooling liquids and slurry produced by the cutting and coring operations.

D. When the cutting or coring will result in the structure or equipment being exposed to provide adequate weather protection.

3.3 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surfaces to receive installation of repairs.

B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work. When excavating in close proximity to piping, duct banks or other items subject to damage, use hand excavation.

C. All equipment and workplace safety shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.

D. Where possible, employ original installer or fabricator to perform cutting and patching for:
1. Weather-exposed or moisture-resistant elements.
2. Sight-exposed finished surfaces.

E. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

F. Restore work which has been cut or removed; install new products to provide completed work in accordance with requirements of Contract Documents.

G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:
1. For continuous surfaces, refinish to nearest intersection.
2. For an assembly, refinish entire unit.

H. Remove rubble and excess patching materials from the premises.

3.4 CORING

A. All coring shall be performed in such a manner as to limit the extent of patching. Locate the rebar before coring to minimize cut throughs.

B. Coring shall be performed with an approved non-impact rotary tool with diamond core drills.

C. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.

D. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

E. Fit to pipes and other penetrations in tanks to be water tight using seals or other methods defined in the specifications.

F. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. All work shall be performed by mechanics skilled in this type of work.

G. If holes are cored through floor slabs they shall be drilled from below where possible. If holes are drilled from above, provide protection and containment below the area being drilled to catch the plug and contain liquid and slurry.

3.5 CUTTING

A. All cutting shall be performed in such a manner as to limit the extent of patching.

B. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

C. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.

D. Provide for control of slurry generated by sawing operation on both sides of wall and from below if cutting a floor.

E. When cutting a reinforced concrete wall or floor, the cutting shall be done so as not to damage the bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.

F. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.

G. Provide equipment of adequate size to remove cut panel.

H. Saw cut concrete and masonry prior to breaking out sections.

I. Install work at such time as to require the minimum amount of cutting and patching.

J. All cutting of structural members shall be done in a manner directed by the Engineer.

K. Cut opening only large enough to allow easy installation of the equipment, ducting, piping or conduit.

L. When existing conduits or pipe sleeves are cut off at the floor line or wall line, they shall be filled with grout or suitable patching material.

3.6 PROTECTION

A. Provide devices and methods to protect other portions of project from damage.

B. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.

C. Maintain excavations free from water.

3.7 PATCHING

A. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.

B. Finish patching shall match existing surfaces as approved.

C. Patching shall be of the same kind and quality of material as was removed.

D. The completed patching work shall restore the surface to its original appearance or better.

E. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed to include the joint between the existing material and the patch.

F. Equipment damaged during cutting and patching shall be replaced or repaired by the equipment manufacturer, at the Engineer's sole discretion and at the expense of the Contractor doing the work.

G. Repaint any damage to factory applied paint finishes using touch-up paint furnished by the equipment manufacturer.

H. Slurry or tailings resulting from coring or cutting operations shall be contained and vacuumed or otherwise removed from the area following drilling or cut.

I. Equipment shall be protected against mechanical and water damage during cutting and patching. Provide protective covers or use other means such as temporary relocation to protect equipment that is at risk of damage from the cutting and patching

J. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

END OF SECTION 017329

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SECTION 017423 - CLEANING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Execute cleaning, during progress of the work, and at completion of the work, as required by General Conditions.

1.2 RELATED WORK

A. Standard General Conditions of the Construction Contract are included in Section 007213.

B. Each Section: Cleaning for specific products or work.

1.3 DISPOSAL AND CLEANING

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.1 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

D. Contractor shall clean all public streets and land of soil deposited by vehicles leaving the site and all debris wind-blown off of the site at the end of every working day.

3.2 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.3 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.

C. Polish glossy surfaces to a clear shine.

D. Ventilating Systems:
   1. Clean permanent filters and replace disposable filters if units were operated during construction.
   2. Clean ducts, blowers and coils if units were operated without filters during construction.

E. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

F. Prior to final completion, or Owner occupancy, conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire work is clean.

END OF SECTION 017423

SECTION 017700 – CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies administrative, verification and procedural requirements for project closeout, including but not limited to:
   1. Final cleaning included in Section 017423.
   2. Project Record Documents included in Section 017839.
   3. Shop Drawings included in Section 013300.
   4. Warranties, guarantees, and bonds included in Section 017836 and applicable Sections in the Technical Specifications.
   5. As-built construction schedule included in Section 013216.

1.2 RELATED WORK

A. Operation and Maintenance (O&M) data and manuals Section 017823 applicable Sections in Technical Divisions.

1.3 CLOSEOUT PROCEDURES

A. Provide all deliverables as specified, prior to submitting the final payment application.

B. Provide submittals to Engineer that are required by governing or other authorities having applicable jurisdiction including but not limited to permit close out information, certificates of occupancy, etc.

C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due, following submittal and approval of Record Documents and Record Drawings.

D. Submit Contractor's Final Release and Release of Liens with final payment application.

1.4 FINAL CLEANING

A. Contractor to complete final cleaning prior to submittal of the final application for payment.

B. Contractor to comply with requirements as specified in Section 017423.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

END OF SECTION 017700

SECTION 017823 – OPERATIONS AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

1.2 RELATED WORK

A. Submittals are included in Section 013300.

B. Contract closeout is included in Section 017700.

C. Warranties and Bonds are included in Section 017836.

1.3 SUBMITTAL SCHEDULE

A. Submit two (2) paper copies or one electronic file of the preliminary operating and maintenance (O&M) instructions with shop drawings for review. Resubmit revised preliminary manuals with corrections and additional requested information prior to shipment of equipment.

B. Submit Asset Registry prior to start-up of the equipment.

C. Submit three (3) final copies and one electronic file of the final operating and maintenance instructions covering all equipment and systems furnished prior to starting operation of the equipment.

D. Submit Spare Parts Registry prior to Substantial Completion.

E. If significant changes are made during start-up and testing, submit revised manuals within 30 days of start-up.
   1. Provide a letter that grants the Engineer and Owner to the limited right to use and reproduce each manual (in it its entirety or any portion thereof) from the respective equipment manufacturer(s). Such limited right shall allow the Engineer and Owner to use each manual or and portion thereof for:
      a. The potential assembly of a comprehensive facility operation and maintenance manual for the sole benefit of the Owner; and,
      b. Supplemental training of the Owner's personnel and operators, over and above the required vendor's training, regarding operation of the facility as a system.

F. The Engineer will review Operation and Maintenance manuals submittals for operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the O&M Manual Review Checklist appended to this Section.

1.4 ASSET REGISTRY

A. Submit Asset Registry for all equipment components and systems purchased for and installed on the project with an initial value exceeding $2,500 and all water quality instruments for entry into the Owner's capital asset database. The registry shall be completed in a Microsoft Excel spreadsheet and submitted in both paper copy and electronic version.

B. Asset Registry shall include the following information in separate columns:
   1. Asset Number
   2. Asset Name
   3. Asset Attributes:
      a. Manufacturer.
      b. Serial Number.
      c. Horsepower.
      d. Capacity.
      e. Etc.
   4. Asset Purchase Cost
   5. Installation Cost (Labor, Overhead, Profit)
   6. Initial Value of Asset (Installed total cost)
   7. Date Asset Placed in Service
   8. Estimated Life
   9. Asset Replacement Cost
   10. Warranty Start Date
   11. Warranty End Date

1.5 SPARE PARTS REGISTRY

A. Submit Spare Parts registry for all maintenance materials and spare parts for equipment provided on the project for entry into the Owner’s inventory management system. Include data or parts provided with the project as well as manufacturer-recommended preventative maintenance items. The registry shall be completed in a Microsoft Excel spreadsheet and submitted in both paper copy and electronic version.

B. Spare Parts Registry shall include the following information in separate columns:
   1. Asset Number and Asset Name for which part is used
   2. Part identification
   3. Part description
   4. Part number / model number / catalog number from Supplier
   5. Part number / model number / catalog number from original equipment manufacturer.
   6. Vendor/Supplier Name
   7. Part number/Catalog number (and referenced catalog edition)
   8. Unit price
   9. Vendor/Supplier internet website address
   10. Vendor/Supplier mailing address
   11. Vendor/Supplier phone number
   12. Vendor/Supplier internet website address
   13. Quantity recommended per asset
   14. Quantity provided under contract
   15. Date part(s) received by Owner

1.6 OPERATING MANUALS

A. Provide specific operation and maintenance instructions for all electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections.

B. Separate manuals shall be provided for each type of equipment, or each Section number. Each manual shall contain the following:
   1. Format and Materials
      a. Binders
         1) Commercial quality three ring binders with durable and cleanable plastic covers
         2) Maximum ring width capacity: 3 inches
         3) When multiple binders are used, correlate the data into related consistent groupings/volumes
      b. Identification: Identify each volume on the cover and spine with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". Include the following
         1) Title of Project.
         2) Identify the general subject matter covered in the manual.
         3) Identify structure(s) and/or location(s), of the equipment provided.
         4) Specification Section number.
      c. 20 lb loose leaf paper, with hole reinforcement
      d. Page size: 8-1/2 inch by 11 inch
      e. Provide heavy-duty fly leafs (section separators), matching the table of contents, for each separate product, each piece of operating equipment, and organizational sections of the manual.
      f. Provide reinforced punched binder tab; bind in with text.
      g. Reduce larger drawings and fold to the size of text pages - but not larger than 11 inches x 17 inches - or provide a suitable clear plastic pocket (with drawing identification) for such folded drawings/diagrams.
   2. Contents:
      a. A Table of Contents/Index divided into section reflective of the major components provided.
      b. Specific description of each system and components.
      c. Name, address, telephone number(s) and e-mail address(es) of vendor(s) and local service representative(s).
      d. Specific on-site operating instructions (including starting and stopping procedures).
      e. Safety considerations.
      f. Project specific operational procedures and recommended log sheet(s).
      g. Project specific maintenance procedures.
      h. Manufacturer's operating and maintenance instructions – specific to the project.
      i. Preventative maintenance schedule and materials required for preventative maintenance activities.
      j. Copy of each wiring diagram.
      k. Copy of approved shop drawing(s) and Contractor's coordination/layout drawing(s).
      l. List of spare parts and recommended quantities.
      m. Product Data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.

n. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
o. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.
p. Warranties and Bonds, as specified in the General Conditions.

3. Transmittals
   a. Prepare separate transmittal sheets for each manual. Each transmittal sheet shall include at least the following: Contractor's name and address, Owner's name, project name, project number, submittal number, description of submittal and number of copies submitted.
   b. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.
   c. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.

1.7 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. Operating instructions shall be prepared specifically for each system or piece of equipment installed under this contract and shall consider the specific equipment and controls included. Instructions shall be complete for each separate system covering:
   1. Equipment functions, normal operating characteristics, and limiting conditions.
   2. Assembly, installation, alignment, adjustment, and checking instructions.
   3. Operating instructions for start-up routine and normal operation, regulation and control, shutdown, seasonal variations, special conditions, and emergency conditions.
   4. Maintenance instructions and schedules including lubrications, disassembly, repair, and reassembly instructions.
   5. Adjustment, alignment, and balancing instructions.
   6. Guide to Troubleshooting.
   7. Parts lists, and predicted life of parts subject to wear.
   8. Outlines, cross-sections, assembly drawings, engineering data, and wiring diagrams.
   9. Testing results, performance curves, and balancing reports where applicable.

B. Remove or cross-out all text, tables, references, pictures, and diagrams describing options and components that have not been included as part of the furnished equipment and systems.

C. Include a completed "MAINTENANCE SUMMARY" as a page near the first page of the preliminary and final O&M Manual. This summary should compile all recommended maintenance tasks for the equipment. Use the form matching "Section 017823 - Supplement 2."

D. Panelboard circuit directories including electrical service characteristics, controls and communications and color-coded wiring diagrams as installed.

E. Control diagrams by controls manufacturer as installed (as-built).

F. Contractor's coordination drawings, with color coded piping diagrams, as installed (as-built).

G. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Include equipment and instrument tag numbers on diagrams.

H. Additional Requirements as specified in individual product specification.

I. Design data for systems engineered by the Contractor or its Suppliers.

1.8 ELECTRONIC OPERATION AND MAINTENANCE MANUALS

A. In addition to the "paper" Operation & Maintenance (O&M) manuals, submit all final O&M Manuals on a CD-ROM in a "text searchable" Portable Document Format (_.pdf), compatible with Adobe Acrobat®. Format shall be compatible with the current version of Adobe Acrobat Reader and at least three previous major revisions.

B. Electronic files shall be an exact match of the reviewed final paper copy, including organization, formatting and bookmarking.

C. Create one PDF document (_.pdf file) for each O&M manual. Direct conversion from the native editable document is strongly recommended (i.e., convert from Word or CAD software directly into PDF.) to ensure the accuracy of the text. Optical character recognition (OCR) may be accepted as long as it is confirmed accurate.

D. Drawings and graphics must be an integral part of the PDF document. All pages must be rotated for clear reading on a computer monitor. Graphic resolution must be adequate to allow the image to be clear on screen and for printing.

E. Create "Bookmarks" in the file for each item in the Table of Contents. Use an outline structure 1 to 3 levels deep, depending on document size. Confirm a bookmark for at least every 10 pages in long documents.

F. Set the initial (opening) view of PDF files as follows:
   1. Page Layout: Single Page
   2. Zoom: Full Page
   3. Bookmarks: Navigation frame open for documents over 15 pages, closed for shorted files.

G. As with the paper copies: in tables showing multiple options, highlight the item provided or cross-out non-applicable information. Cross-out figures and other items showing features that have not been provided on the project.
   1. To make such markings, preferred method is in the native format document, prior to translation to PDF file.
   2. Markings using Acrobat Professional editing tools will also be accepted.

H. Filenames use the convention XXXXXX_POM_Name.pdf or XXXXXX_OM_Name.pdf, where XXXXXX is the specification section number and "Name" is a very short description. Use underscore characters in lieu of spaces.
   1. Example: 402724_POM_Plug_Valves.pdf - for preliminary review copy
   2. Example: 402724_POM2_Plug_Valves.pdf - for resubmittal of preliminary review copy
   3. Example: 402724_OM_Plug_Valves.pdf - for Final copy

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 VENDOR TRAINING / INSTRUCTIONS (TO OWNER'S PERSONNEL)

A. Before final initiation of operation, Contractor's vendors shall train/instruct Owner's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the Owner. Training shall be provided both in the classroom and in the field at the equipment or system.

B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of eight (8) hours of training for each type of equipment and for each chemical system. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of Owner's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the Contractor's "normal working hours" or the Owner's normal day shift.

C. Use operation and maintenance manuals as basis for instruction. Train/instruct the Owner's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.

D. At least two weeks prior to the schedule for vendor training, a detailed lesson plan, representative of the material to be covered during instruction, shall be submitted to the Engineer for approval. Lesson plans shall consist of in-depth outlines of the training material, including a table of contents, resume of the instructor, materials to be covered, start-up procedures, maintenance requirements, safety considerations, and shutdown procedures.

E. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.

3.2 VIDEOGRAPHY OF VENDOR TRAINING / INSTRUCTION

A. Audio/video (A/V) record (*.wmv or *.mpeg4) training/instructions as they are being provided to the Owner's personnel. Such recording shall include the entire training/instruction session(s) as well as all questions and answers. A/V recording shall be performed by a professional organization experienced in the production of such recordings. Self-recording by the Contractor may be considered, provided that Contractor can demonstrate, in advance, proficient examples of such recordings.

B. To avoid audio problems, training/instruction shall be held in a location sufficiently removed from construction activity, insulated from the noise of construction activity, or during a time when construction activity is not occurring in the vicinity.

C. The audio portion of the A/V recording should be done with a microphone (wired or wireless) attached to the trainer/instructor to maximize the quality of speech.

D. Each A/V recording should have "chapters" to segregate the distinct portions of the training/instruction or have visual cues at the start of a change in subject.

E. The training in the classroom and at the equipment/system shall be recorded.

F. Computer files of the A/V recordings (*.wmv or *.mp4) shall be submitted to the Engineer.

ATTACHMENTS

Supplement 1 – O&M Review Checklist

Supplement 2 – Maintenance Summary

Supplement 3 – Equipment Manufacturer’s Certification of Installation, Testing, and Instruction

END OF SECTION 017823

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SUPPLEMENT 1
O&M Manual Review Checklist

Submittal No.: _____

Project No.: _____

Manufacturer: _____

Equipment Submitted: _____

Specification Section: _____

Date of Submittal:

General Data		
1.	Are the area representative's name, address, e-mail address and telephone number included?	
2.	Is the nameplate data for each component included?	
3.	Are all associated components related to the specific equipment included?	
4.	Is non-pertinent data crossed out or deleted?	
5.	Are drawings neatly folded and/or inserted into packets?	
6.	Are all pages properly aligned and scanned legibly?	
7.	Is the .PDF document bookmarked according to the table of contents?	
Operations and Maintenance Data		
8.	Is an overview description of the equipment and/or process included?	
9.	Does the description include the practical theory of operation?	
10.	Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)?	
11.	Are alarm and shutdown conditions specific to the equipment provided on this project clearly identified? Does it describe possible causes and recommended remedies?	
12.	Are step procedures for starting, stopping, and troubleshooting specific to the equipment provided included?	
13.	Is a list of operational parameters to monitor and record specific to the equipment provided included?	
14.	Is a proposed operating log sheet specific to the equipment provided included?	
15.	Is a spare parts inventory list included for each component?	
16.	Is a lubrication schedule for each component specific to the equipment provided included - or does it clearly state “No Lubrication Required"?	
17.	Is a maintenance schedule for each component specific to the equipment provided included?	
18.	Is a copy of the warranty information included?	
19.	Are preventative maintenance activities and the materials required to complete these activities clearly outlined?	

Review Comments

Is the submittal fully approved (yes/no)? _____

If not, the following points of rejection must be addressed and require resubmittal by the Contractor:

Item No.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14, _____
15. _____

Reviewed By: _____ Date: _____

Legend

1 = OK

2 = Not Adequate

3 = Not Included

Note: This submittal has been reviewed for compliance with the Contract Documents.

SUPPLEMENT 2
Maintenance Summary

Project Name:	
Date:	
Equipment Description:	
Manufacturer:	
Manufacturer Contact Information:	Address: City: State, Zip: Phone(s):
Manufacturer's Local Representative:	Company: Address: City: State, Zip: Phone(s):

Equipment Item	Tag Number:	Weight if Over 100 pounds:	Nameplate Data: (HP, Capacity, Flow, TDH, speed, voltage, etc.)

Maintenance Requirements		
Maintenance Task & Comments Describe every preventative maintenance task and refer to location in project-specific O&M Manual if more information is needed.	**Frequency**	**Lubricant** (if needed) Generic Name or Code Name to be described below.

Lubricant List

Generic Name or Code Name	List recommended equivalent lubricants from each manufacturer for the specific use.				
	Shell	**Exxon Mobile**	**Chevron Tex-aco**	**BP Amoco**	**Other**

Recommended Spare Parts

For Owner Inventory

Description	Part Number	Original Source Manufacturer & Part Number	Count / Quantity	Unit Price

Note: Identify parts provided by this Contract with two asterisks **.

SECTION 017836 – WARRANTIES AND BONDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

1.2 RELATED WORK

A. Refer to Conditions of Contract for the general requirements relating to warranties and bonds.

B. General closeout requirements are included in Section 017700 – Contract Closeout.

C. Specific requirements for warranties for the work and products and installations that are specified to be warranted are included in the individual Sections.

1.3 SUBMITTALS

A. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the work, or a designated portion of the work, submit written warranties upon request of the Owner.

B. Forms for special warranties are included at the end of this Section. Prepare a written document utilizing the appropriate form, ready for execution by the Contractor, or the Contractor and subcontractor, supplier or manufacturer. Submit a draft to the Owner for approval prior to final execution.

C. Refer to individual Sections for specific content requirements, and particular requirements for submittal of special warranties.

D. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8½-inch by 11-inch paper.

E. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Section in which specified and the name of the product or work item.

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

G. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS", the project title or name and the name, address and telephone number of the Contractor.

H. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

1.4 WARRANTY REQUIREMENT

A. Related Damages and Losses: When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

B. Reinstatement of Warranty: When work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that work covered by a warranty has failed, replace or rebuild the work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefited from use of the work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the contract Documents.

F. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the products, nor does it relieve suppliers, manufacturers and subcontractors required to countersign special warranties with the Contractor.

1.5 MANUFACTURERS CERTIFICATIONS

A. Where required, the Contractor shall supply evidence, satisfactory to the Engineer, that the Contractor can obtain manufacturers' certifications as to the Contractor's installation of equipment.

1.6 DEFINITIONS

A. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

B. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017836

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SECTION 017839 – PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall keep and maintain, at the job site, a copy of contract documents, marked up to indicate all changes made during the course of a project, as specified herein.

1.2 RELATED REQUIREMENTS

A. Contract close-out submittals are included in Section 017700.

B. Warranties and bonds are included in Section 017836.

1.3 REQUIREMENTS INCLUDED

A. Contractor shall maintain a record copy of the following documents, marked up to indicate all changes made during the course of a project:
   1. Contract Drawings.
   2. Specifications.

B. Contractor shall assemble copies of the following documents for turnover to the Engineer at the end of the project, as specified.
   1. Field Orders, Change Orders, Design Modifications, and RFIs.
   2. Field Test records.
   3. Permits and permit close-outs (final approvals).
   4. Certificate of Occupancy or Certificate of Completion, as applicable.
   5. Laboratory test reports (e.g., bacteriological and primary & secondary water quality).
   6. Certificates of Compliance for materials and equipment.
   7. Record Shop Drawings.
   8. Samples.

1.4 RECORD DRAWINGS

A. The Contractor shall annotate (mark-up) the Contract Drawings to indicate all project conditions, locations, configurations, and any other changes or deviations that vary from the original Contract Drawings. This requirement includes, but is not limited to, buried or concealed construction, and utility features that are revealed during the course of construction. Special attention shall be given to recording the locations (horizontal and vertical) and material of all buried utilities that are encountered during construction – whether or not they were indicated on the Contract Drawings. The record information added to the drawings may be supplemented by detailed sketches, if necessary, clearly indicating, the WORK, as constructed.

B. These annotated Contract Drawings constitute The Contractor's Record Drawings and are actual representations of as-built conditions, including all revisions made necessary by change orders, design modifications, requests for information and field orders.

C. Record drawings shall be accessible to the Owner and Engineer at all times during the construction period.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES

A. Store documents and samples in Contractor's field office apart from documents used for construction.
   1. Provide files and racks for storage of the record documents.
   2. Provide locked cabinet(s) or secure storage space for storage of samples.

B. File documents and samples in accordance with Construction Specifications Institute (CSI) format.

C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.

D. Make documents and sample available for inspection by the Engineer or Owner at all times.

E. Up-to-date Record Drawings may be a pre-requisite of processing periodic monthly pay applications, if so specified under the section for progress payments.

3.2 MARKING METHOD

A. Use the color Red (indelible ink) to record information on the Drawings and Specifications.

B. Label each document "PROJECT RECORD" in neat large printed letters.

C. Unless otherwise specified elsewhere, notations shall be affixed to hardcopies of documents.

D. Record information contemporaneously with construction progress.

E. Legibly mark drawings with as-built information:
   1. Elevations and dimensions of structures and structural elements.
   2. All underground utilities (piping and electrical), structures, and appurtenances.
      a. Changes to existing structure, piping and appurtenance locations.
      b. Record horizontal and vertical locations of underground structures, piping, utilities and appurtenances, referenced to permanent surface improvements.
      c. Record actual installed pipe material, class, size, joint type, etc.

3.3 RECORD INFORMATION COMPILATION

A. Do not conceal any work until the required information is acquired.

B. Items to be recorded include, but are not limited to:
   1. Location of internal utilities and appurtenances concealed in the construction – referenced to visible and accessible features.

      a. Field changes of dimensions and/or details
      b. Interior equipment and piping relocations.
      c. Architectural and structural changes, including relocation of doors, windows, etc.
   2. Architectural schedule changes.

C. Changes made by Field Order, Change Order, design modification, and RFI.

D. Details not indicated on the original Contract Drawings.

E. Specifications - legibly mark each Section to record:
   1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.
   2. Changes made by Field Order, Change Order, RFI, and approved shop drawing.

3.4 SUBMITTAL

A. If specified under the section for progress payments, monthly applications for payment will be contingent upon up-to-date Record Drawings. If requested by the Engineer or Owner, Contractor shall provide a copy of the Record Drawings, or present them for review prior to processing monthly applications for payment.

B. Upon substantial completion of the work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Drawings to the Engineer conforming to the construction records of the Contractor. The set of drawings shall consist of corrected and annotated drawings showing the recorded location(s) of the work. Unless specified otherwise elsewhere, Record Drawings shall be in the form of a set of prints with annotations carefully and neatly superimposed on the drawings in red.

C. Upon substantial completion of the work and prior to final acceptance, the Contractor shall finalize and deliver a complete set of Record Documents to the Engineer conforming to the construction records of the Contractor. The set of documents shall consist of corrected and annotated documents showing the as-installed equipment and all other as-built conditions not indicated on the Record Drawings.

D. The information submitted by the Contractor into the Record Drawings and Record Documents will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information and shall bear the costs resulting from the correction of incorrect data.

E. Delivery of Record Drawings and Record Documents to the Engineer will be a prerequisite to Final payment.

F. The Contractor shall maintain a copy of all books, records, and documents pertinent to the performance under this Agreement for a period of five years following completion of the contract.

END OF SECTION 017839

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

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. Formwork for cast-in-place concrete.
2. Form accessories.
3. Form stripping.

B. Related Requirements:
1. Section 032000 – Concrete Reinforcing: Reinforcing steel and required supports for cast-in-place concrete.
2. Section 033000 – Cast-in-Place Concrete: Cast-in-place concrete.
3. Section 033500 – Concrete Finishing.
4. Section 042000 – Unit Masonry: Product requirements for masonry accessories for placement by this Section.
5. Section 050519 – Post-Installed Anchors for testing of drilled in injection adhesive anchor system.
6. Section 055000 – Metal Fabrications: Product requirements for metal fabrications for placement by this Section.
7. Various Sections in Divisions 21, 22, and 23: Product requirements for fire suppression, plumbing, and HVAC items for placement by this Section.
8. Various Sections in Divisions 26, 27, and 28: Product requirements for electrical, communications, and security items for placement by this Section.
9. Section 315000 – Excavation Support and Protection: Execution requirements for shoring and underpinning required by this Section.

1.3 COORDINATION

A. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.4 ACTION SUBMITTALS

A. Section 013300 – Submittal Procedures: Requirements for submittals.

B. Shop Drawings:
1. Indicate:
a. Formwork, shoring, and reshoring.

b. Pertinent dimensions, openings, details of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
c. Means of leakage prevention for concrete exposed to view in finished construction.
d. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.
e. Procedure and schedule for removal of shores and installation and removal of reshores.
f. Location and sequence of concrete placement.
g. Form release agent.
h. Form ties.
i. Bond breakers.

C. Review of submittals will be for appearance, performance, and strength of completed structure only. Approval by the Engineer will not relieve Contractor of responsibility for the strength, safety, or correctness of methods used, the adequacy of equipment, or from carrying out the work as shown on Contract Documents.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Delegated Design Submittals:
1. Submit signed and sealed Shop Drawings with design calculations and assumptions for formwork.
2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.
3. Include signed and sealed structural calculations to support design for project records. Calculations will not be reviewed.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Qualifications Statement:
1. Submit qualifications for licensed professional.

E. Certify that form release agent complies with Federal, State and local VOC limitations.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 347, 301, and 318.

B. For wood products furnished for Work of this Section, comply with AF&PA.

1.7 SYSTEM DESCRIPTION

A. Delegated Design Structural Design Responsibility: Provide forms, shoring, and reshoring designed by a professional engineer registered in the State of Michigan. Design formwork in accordance with the requirements of ACI 301, ACI 318 and ACI 347. Comply with all

applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

1.8 QUALIFICATIONS

A. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and construct formwork, shoring, and bracing according to ACI 318, ACI 347, ACI 347.2R, conforming to Michigan Building Code requirements to achieve concrete shapes, lines, and dimensions as indicated and required by project conditions.

B. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E96, water method.

2.2 FORMS, GENERAL

A. Make forms for cast-in-place concrete of wood, steel, or other approved materials. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 033500 “Concrete Finishing.”
   1. Construct wood forms of sound lumber or plywood free from knotholes and loose knots.
   2. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.

B. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand high hydraulic pressures resulting from rapid filling of forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern or as indicated on Drawings.

C. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, or caulk joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.

D. Provide 3/4 inch chamfer on form corners unless otherwise indicated.

2.3 FORMS FOR STRUCTURAL CONCRETE

A. Plywood Forms:
   1. Make forms for exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels.
   2. Species: Douglas fir.
   3. Grade: B grader or better.
   4. Edges: Clean and true.
   5. Exposed Concrete:
      a. Comply with APA/EWA PS 1.
      b. Panels: Full size, 4 by 8 feet.
      c. Label each panel with grade trademark of APA/EWA
   6. Surfaces to Receive Membrane Waterproofing:
      a. Minimum Thickness: 5/8 inch.
      b. Grade: APA/EWA "B-B Plyform Structural I Exterior."
   7. "Smooth Finish" Indicated on Drawings:
      a. Minimum Thickness: 3/4 inch.
      b. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."
   8. Design and construct forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing, except as specified in Section 033500 “Concrete Finishing.”

B. Preformed Steel Forms:
   1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
   2. Minimum Thickness: 16 gauge.

C. FRP Forms: Matched, tightly fitted, and stiffened to support weight and pressure of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Steel Forms: Description: Sheet steel, suitably reinforced.

E. Smooth Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.

F. Framing, Studding, and Bracing: Stud or No. 3 structural light-framing grade.

2.4 COATINGS

A. Coatings for Aluminum:
   1. Polyamide epoxy finish coat with paint manufacturer's recommended primer for aluminum substrate.
   2. One coat primer and one coat finish.
   3. Minimum Total Dry Film Thickness: 10 mils.

2.5 FORMWORK ACCESSORIES

A. Form Ties:
   1. Type: Snap off.

2. Material: Galvanized.
3. Length: Fixed.
4. Furnish waterproofing washer.
5. Back Break Dimension: 1 ¼ inches.
6. Free of defects capable of leaving holes larger than 1-1/4 inch in concrete surface.
7. Coil and Wire Ties: Provide ties manufactured so that after removal of projecting part, no metal remains within 1-1/2 inch of concrete face. The part of the tie to be removed shall be at least 1/2-in diameter or be provided with a plastic or wooden cone at least 1/2 inch1/2-in diameter and 1-1/2 inch long. Provide cone washer type form ties in concrete exposed to view.
8. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2 inch and manufactured to permit patching of the tie hole.
9. Provide ties for liquid retaining structures and exterior below grade basement walls that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.
10. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of same minimum size may be used. Install in forms so that large end is, where applicable, on liquid or backfilled side of the wall. Clean, fill, and seal form tie hole with rubber plug installed from the liquid or backfilled side and non-shrink cement grout to provide watertight form tie holes. Make repairs needed to make watertight.
11. Alternate form ties specified in Paragraph above may be used when forms are to be set against previously placed or existing concrete walls. Use in conjunction with cast-in threaded inserts or drilled-in threaded anchors so that no metal remains within expansion joint upon removal of tapered through bolt. Conform to requirements specified in above Paragraph.

B. Spreaders:
1. Description: Standard, non-corrosive, metal-form clamp assembly of type acting as spreaders and leaving no metal within 1 inch of concrete face.
2. Wire ties, wood spreaders, or through bolts are not permitted.

C. Form Release Agent:
1. Description: Colorless form coating that will not stain concrete or absorb moisture or impair natural bonding or color characteristics of coating intended for use on concrete.
2. Form Release Agent. Coat form surfaces in contact with concrete with an effective, non-staining, non-residual, water based, bond-breaking form coating, unless otherwise indicated or specified. Form release agent shall not impair the bond of paint, sealant, dampproofing, or other coatings.
3. For concrete surfaces which are to be painted, use forms with high density overlay or a similar material which does not require a form release agent unless Contractor can substantiate to satisfaction of the Engineer that form release agent will not remain on formed surface after it is stripped.

D. Bond Breaker:
1. Bond breakers for precast and tilt-up construction when cast against concrete shall be a non-staining, non-residual type, which will provide a positive bond prevention.
2. Acceptable Manufacturers: One of the following or equal:
   a. Dayton Superior Specialty Chemical Corporation: Sure-Lift (J-6).
   b. Universal Form Clamp Co: Super Clean and Tilt.
   c. Nox-Crete Products Group: Silcoseal Select.

E. Corners:
   1. Type: Chamfer, as indicated.

F. Vapor Retarder:
   1. Description: Polyethylene sheet.
   2. Thickness: 8 mils.

G. Nails, Spikes, Lag Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork.

B. Verify that dimensions agree with Drawings.

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

3.2 INSTALLATION

A. Earth Forms: Not permitted.

B. Formwork:
   1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
   2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
   3. Camber forms where necessary to produce level finished soffits unless indicated otherwise on Drawings.
   4. Positioning:
      a. Carefully verify horizontal and vertical positions of forms.
      b. Correct misaligned or misplaced forms before placing concrete.
   5. Complete wedging and bracing before placing concrete.
   6. Erect formwork, shoring, and bracing according to ACI 301, 318, 347.
   7. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.
   8. Install chamfer strips for corners.
   9. Form Release Agent:
      a. Apply according to manufacturer instructions.
      b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
      c. Do not apply form release agent if concrete surfaces are indicated to receive special finishes that may be affected by agent.

d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.
e. Apply form coatings before placing reinforcing steel.

10. Leave forms in place for minimum number of days according to ACI 347.
11. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and until the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces.
12. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
13. Stripping:
    a. Arrange and assemble formwork to permit dismantling and stripping.
    b. Do not damage concrete during stripping.
    c. Permit removal of remaining principal shores.
14. Be responsible for damage resulting from removal of forms and make repairs at no additional compensation. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to requirements for form removal specified in Section 033000 “Cast-in-Place Concrete.”
15. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.
16. Discard damaged forms.
17. Reuse and Coating of Forms:
    a. Thoroughly clean forms and reapply form coating before each reuse.
    b. For exposed Work, do not reuse forms with damaged faces or edges.
    c. Apply form coating to forms according to manufacturer instructions.
    d. Do not coat forms for concrete indicated to receive "scored finish."
18. Do not reuse wood formwork more than 4 times for concrete surfaces to be exposed to view.
19. Do not patch formwork.
20. Form Cleaning:
    a. Clean forms as erection proceeds to remove foreign matter within forms.
    b. Clean formed cavities of debris prior to placing concrete.
    c. Flush with water or use compressed air to remove remaining foreign matter.
    d. Ensure that water and debris drain to exterior through cleanout ports.
    e. Consider including following Subparagraph if formwork will be erected during cold weather.
    f. Cold Weather:
        1) During cold weather, remove ice and snow from within forms.
        2) Do not use de-icing salts.
        3) Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure; use compressed air or other dry method to remove foreign matter.

C. Forms for Smooth Finish Concrete:
1. Use steel, plywood, or lined-board forms.
2. Use clean and smooth plywood and smooth sheet form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
3. Install smooth sheet form lining with close-fitting square joints between separate sheets without springing into place.
4. Use full-sized sheets of smooth sheet form liners and plywood wherever possible.
5. Tape joints to prevent protrusions in concrete.

6. Apply forming and strip wood forms in a manner to protect corners and edges.
7. Level and continue horizontal joints.

D. Form Anchors and Hangers:
1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

E. Inserts, Embedded Parts, and Openings:
1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.
6. Install formed openings for items to be embedded in or passing through concrete Work.
7. Locate and set in place items required to be cast directly into concrete.
8. Following Subparagraph is example for specific or special items requiring placement in forms. Add Subparagraphs for other items for Project conditions.
9. Position recessed dovetail slots for brick veneer masonry anchors according to spacing and intervals as specified in Section 042000 - Unit Masonry.
10. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.
11. Frame openings in concrete where indicated on Drawings.
12. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.
13. Coordinate Work to avoid cutting and patching of concrete after placement.
14. Temporary Openings:
    a. Provide temporary ports or openings in formwork as required to facilitate cleaning
    b. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
    c. Locate openings at bottom of forms to allow flushing water to drain.
    d. Remove chips, sawdust, and other debris.
    e. Thoroughly blow out forms with compressed air just before concrete is placed and inspection.
    f. Clean forms and surfaces against which concrete is to be placed.
    g. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

F. Form Ties:
1. Provide sufficient strength and quantity to prevent spreading of forms.
2. Place ties at least 1 inch away from edge of concrete.
3. Leave inner rods in concrete when forms are stripped.
4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.

G. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

H. Construction Joints:
1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.
2. Just prior to subsequent concrete placement, remove strip, and tighten forms to conceal shrinkage.
3. Appearance:
   a. Show no overlapping of construction joints.
   b. Construct joints to present same appearance as butted plywood joints.
4. Arrange joints in continuous line straight, true, and sharp.

I. Embedded Items:
1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.
2. Do not embed wood or uncoated aluminum in concrete.
3. Obtain installation and setting information for embedded items furnished under other Sections.
4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

J. Screeds:
1. Set screeds and establish levels for tops of and finish on concrete slabs.
2. Slope slabs to drain where required or as indicated on Drawings.
3. Before depositing concrete, remove debris from space to be occupied by concrete, thoroughly wet forms, and remove freestanding water.

K. Screed Supports:
1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.
2. Staking through membrane is not permitted.

L. Cleanouts and Access Panels:
1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.
2. Clean forms and surfaces against which concrete is to be placed.
3. Remove chips, sawdust, and other debris.
4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

A. Construct formwork to maintain tolerances according to ACI 301.

B. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus 1 inch from the intended surface indicated.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Inspection:
   1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.
   2. Notify Engineer after placement of reinforcing steel in forms at least six working hours prior to proposed concrete placement.
   3. Schedule concrete placement to permit formwork inspection before placing concrete.
   4. Failure of forms to comply with specified requirements or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of concrete work. Repair or replace rejected work as directed by the Engineer at no additional compensation. Make required repair or replacement subject to requirements of these Specifications and approval of the Engineer.

3.5 SCHEDULE

A. Concrete Not Exposed to View: Site-fabricated plywood coated with form oil.

B. Concrete Exposed to View: New and unused Plyform exterior grade plywood panels or steel forms.

END OF SECTION 031000.00

SECTION 031500 – CONCRETE JOINTS AND ACCESSORIES

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 construction of durable, watertight joints in concrete structures.

B. Related Requirements:
1. Section 031000 “Concrete Forming and Accessories” for formwork.
2. Section 032000 “Concrete Reinforcing” for reinforcing.
3. Section 033000 “Cast-In-Place Concrete” for cement, and related concrete products.
4. Section 033500 “Concrete Finishing” for concrete finish related work.
5. Section 033900 “Concrete Curing” for concrete curing.
6. Section 034113 “Precast Concrete Hollow Core Planks” for precast concrete hollow core planks related work.
7. Section 033600 “Grout” for grout related work.
8. Section 055000 “Metal Fabrications for various metal fabrications.

1.3 ACTION SUBMITTALS

A. Plastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to CRD standards, details, and samples of factory fabrications.

1.4 INFORMATIONAL SUBMITTALS

A. System and Material Certificates:
1. Certify that materials used within joint system are compatible with each other.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer An authorized representative who is trained and approved by manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Use materials in a given joint that are compatible with one another. Coordinate selection of suppliers and products to provide compatibility.

B. Product Experience: Provide plastic waterstops specifically manufactured for intended purpose and have five years' successfully experience in similar applications.

2.2 MATERIALS - STANDARD WATERSTOPS

A. Plastic Waterstops: Conform to CRD C572, fabricate by extruding elastomeric plastic compound with virgin polyvinylchloride as basic resins and with compound containing no reprocessed materials. Incorporate an integral fastening system or provide with grommets or prepunched holes between outermost ribs at a spacing of 12 inches on center.
   1. Waterstops For Non-Expansion Joints and Joints Indicated:
      a. Type: Ribbed type waterstops.
      b. Minimum Tensile Strength: 1,750 psi per ASTM D 638.
      c. Size: 6 inches by 3/8 inch.
      d. Acceptable Manufacturers: Provide products manufactured by one of the following or equal:
         1) Greenstreak Plastic Products: Style 679.
         2) Paul Murphy Plastics Co.: Style FR-6380.
         3) Vinylex Corp.: Style R6-38.
   2. Factory Fabrications:
      a. Provide factory fabrications for waterstop changes of direction, transitions, and intersections:
         1) Intersections: Vertical ells, flat ells, vertical tees, flat tees, vertical crosses, flat crosses, and special, unusual, or complicated intersections including waterstop intersections of different sizes or configurations, and intersections due to joint offsets.
      b. Make and inspect factory fabrications by waterstop manufacturer.
      c. Provide stub ends of sufficient length to leave only straight butt joints for field splicing.

B. Grout: Non-metallic, non-shrinking as specified in Section 033600 "Grouting."

PART 3 - EXECUTION

3.1 INSTALLATION - WATERSTOPS, GENERAL

A. Install waterstops for joints indicated and according to manufacturer's published installation instructions and approved submittals.

B. Include waterstops continuous around corners and intersections to provide a continuous seal.

C. Provide a minimum number of connections or splices. Replace connections or splices that do not meet specified requirements at no additional cost to Owner.

D. Secure waterstops in joints before concrete is placed.

E. Install plastic waterstops so that half of width is embedded on each side of joint. Provide waterstops completely embedded in void-free concrete.

F. Terminate waterstops 2 inch below exposed top of walls.

G. Protect waterstops from damage in intervals between placing waterstops and subsequent placing of concrete. Replace damaged or punctured waterstops at no additional cost to Owner.

H. Protect plastic waterstops from sunlight when exposed more than 30 days between concrete placements.

I. Provide waterstops free from form release agent, bond breaker, dirt, concrete splatter, ice, mortar, paint, or other deleterious material that could reduce or destroy bond between waterstop and adjacent concrete.

3.2 INSTALLATION - PLASTIC WATERSTOPS

A. Field Splices: Make only straight butt joints. Fabricate splices on a bench.
   1. Use a power saw and guide to cut straight ends to be spliced.
   2. Heat fuse weld splices using a Teflon coated thermostatically controlled waterstop splicing iron following manufacturer's recommendations.
   3. Provide finished splices having a cross-section that is dense and free of porosity. Engineer may conduct destructive tests of splices by cutting along one-half of splice length and by cutting perpendicular to splice at several locations on remaining half of splice length.
   4. Completed Splices: Exhibit a continuous and uniform bead of excess melted material with welded material looking similar to parent material.
   5. Show no misalignment of center bulbs or ribs greater than 1/16 inch, lack of fusion, porosity, pinholes, cracks, charred or burnt material, bubbles, or separation of cooled splice when bent by hand. If a splice displays any of these defects, reject the splice, recut back at least 1 inch from rejected splice on each side, and reweld.

B. Secure waterstops in wall joints before concrete is placed. If waterstop does not incorporate an integral fastening system, grommets, or prepunched holes, drill holes in waterstops between outermost ribs at each edge. Center waterstop in the joint. Tie both edges of waterstop to reinforcing steel with tie wire as specified for tying reinforcing steel. Secure waterstop centered on and perpendicular to joint and to maintain its position during concrete placement.

C. Space waterstop ties to match spacing of adjacent reinforcing, but ties need not be spaced closer than 12 inches on center.

D. Clamp horizontal waterstops in slabs in position with form bulkhead, unless previously set in concrete. Lift waterstop edge while placing concrete below the waterstop. Manually force waterstop against and into placed concrete and cover with fresh concrete, to provide complete encasement of waterstop in concrete.

3.3 INSTALLATION - CONSTRUCTION JOINTS

A. Make construction joints only at locations indicated or as approved by the Engineer. Submit additional or relocation of construction joints proposed by Contractor to the Engineer for written approval. Do not eliminate construction joints.

B. Locate additional or relocated joints where they least impair member strength. In general, locate joints within middle third of spans of slabs, beams, and girders.
   1. If a beam intersects a girder at joint, offset joint a distance equal to twice the width of member being connected.
   2. Locate joints in walls and columns at underside of floors, slabs, beams, or girders and at tops of footings.
   3. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.

C. Unless otherwise indicated, provide joints perpendicular to main reinforcement. Continue reinforcing steel through joint as indicated.

D. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations indicated.

E. Roughened Construction Joints:
   1. At construction joints and at concrete joints indicated, uniformly roughen concrete surface with chipping tools to expose a fresh face 1/4 inch of a full amplitude, distance between high and low points and side to side.
   2. Thoroughly clean joint surfaces of loose or weakened materials by waterblasting or sandblasting and prepare for bonding.
   3. At least two hours before and again shortly before new concrete is deposited, saturate joints with water.
   4. After glistening water disappears, coat joints with neat cement slurry mixed to consistency of very heavy paste. Apply a coating to surfaces at least 1/8 inch, scrubbed-in by means of stiff bristle brushes. Deposit new concrete before neat cement dries.

3.4 INSTALLATION - PARTIAL CONTRACTION JOINTS

A. Make partial contraction joints at locations indicated. Do not eliminate or relocate partial contraction joints.

B. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on Drawings. Coat concrete surface with a bond breaker prior to placing new concrete against it as indicated on Drawings.
   1. Do not coat reinforcement with bond breaker. Mask reinforcing passing through joint to prevent bond breaker from running or dripping on to them. Remove masking prior to concrete placement.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect system components verifying that installation conforms to manufacturer’s installation instructions.,
   1. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces removing excess spills.

B. Protect installed products until subsequent work is installed. For exposed materials, protect from damage until Substantial Completion.

END OF SECTION 031500

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SECTION 032000 - CONCRETE REINFORCING

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. Reinforcing bars.
   2. Welded wire fabric.
   3. Reinforcement accessories.

B. Related Requirements:
   1. Section 031000 - Concrete Forming and Accessories: Form materials, and accessories required to form cast-in-place concrete.
   2. Section 031500 – Concrete Joints and Accessories: Waterstops, and accessories for cast-in-place concrete.
   3. Section 033000 - Cast-in-Place Concrete: Cast-in-place concrete.
   4. Section 033500 - Concrete Finishing: Reinforcement for concrete floor toppings.
   5. Section 034113.00 - Precast Concrete Hollow Core Planks for reinforcing within grouted cells and keyways.
   6. Section 042000 - Reinforcement for Masonry.
   7. Section 260526 - Grounding and Bonding for Electrical Systems: Grounding concrete reinforcement.

1.3 COORDINATION

A. Coordinate Work of this Section with placement of formwork, formed openings, masonry dowels, and other Work.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Convene minimum two weeks prior to commencing Work of this Section. Hold a preinstallation conference to review requirements for reinforcement placement, and jointing. Notify all parties involved, including the Engineer. Prepare an agenda for meeting take meeting minutes, and distribute to meeting attendees.

C. Review Contractor’s inspecting agency procedures for field quality control; construction joint, partial contraction joint, anchor rod and anchorage device installation tolerances; steel reinforcement installation, reinforcing splicing devices and concrete protection.

D. Attendees:
   1. Owner.
   2. Resident Engineer.
   3. Contractor.
   4. Engineer.
   5. Manufacturer Representative.
   6. Metal Building System Representative.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings:
   1. Indicate bar sizes, spacings, locations, splice locations, and quantities of reinforcing steel and welded wire fabric.
   2. Indicate bending and cutting schedules.
   3. Indicate supporting and spacing devices.
   4. Placement Drawings:
      a. Walls: Show elevations from outside, looking towards the structure, at a minimum scale of ¼-inch to one foot.
      b. Slabs: Show top and bottom reinforcement on separate plan views, as needed for clarity.
      c. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements and assemblies, all as required for the fabrication and placement of concrete reinforcement.
      d. Reference bars to same identification marks shown on bar bending details. Identify bars to have special coatings or to be of special steel or special yield strength.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Submit certified copies of mill test report of reinforcement materials analysis.

C. Certified copy of test reports for each foreign manufactured steel proposed for use. Provide tests specifically made for this project by a domestic independent testing laboratory certified to perform the tests. Test for conformity to applicable ASTM Standard.

D. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

E. Source Quality-Control Submittals: Indicate results of shop factory tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

1.7 QUALITY ASSURANCE

A. Perform Work according to CRSI 10-MSP, ACI 301 and ACI 318.

B. Prepare Shop Drawings according to ACI SP-66.

C. Maintain one copy of each standard affecting Work of this Section on Site.

D. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 – Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Ship and store reinforcement with bars of same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing same "mark" designations as those shown on submitted placement drawings. Indicate that reinforcing is weldable on tags for ASTM A 706 reinforcing and for ASTM A 615 reinforcing meeting specified requirements in PART 2.

D. Store materials according to manufacturer instructions.

E. Protection:
   1. Protect materials from moisture by storing off ground, in clean, and dry location.
   2. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel:
   1. Comply with ASTM A 615.
   2. Yield Strength: 60 ksi.
   3. Billet Bars: Deformed.
   4. Finish: Uncoated.

B. Deformed Wire:
   1. Comply with ASTM A 1064.
   2. Finish: Uncoated.

C. Fabricated Welded Deformed Wire Fabric:

1. Comply with ASTM A 1064 and ASTM A 615 Grade 60 deformed bars.
2. Configuration: Flat sheets.
3. Finish: Uncoated.

2.2 FABRICATION

A. Fabricate concrete reinforcement according to CRSI 10-MSP and ACI 318.

B. Form standard hooks for 180-degree bends, 90-degree bends, stirrups and tie hooks as indicated.

C. Form reinforcement bends with minimum diameters according to ACI 318.

D. Bend bars cold. Do not straighten or rebend bars.

E. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318.

F. Weld reinforcement only where indicated or specifically approved by the Engineer. Weld reinforcement conforming to AWS D1.4.

2.3 ACCESSORY MATERIALS

A. Tie Wire:
1. Minimum 16 gage, annealed type. Use black wire to tie uncoated reinforcing.

B. Reinforcing Steel Accessories:
1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.
2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with CRSI 10-MSP for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.

B. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.

C. Do not weld reinforcing steel bars either during fabrication or erection unless indicated or as specified herein, or unless prior written approval has been obtained from the Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

D. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.

E. Place, support, and secure reinforcement against displacement. Secure dowels in place before placing concrete.

F. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

G. Do not deviate from required position beyond specified tolerance.

H. Do not field bend reinforcing unless indicated or specifically authorized in writing by the Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using exothermic welding type reinforcing splicing devices, or otherwise repair damaged reinforcing bars as directed by the Engineer at no additional cost to Owner. Do not bend reinforcement after it is embedded in concrete unless indicated.

I. Do not displace or damage vapor retarder.

J. Chairs, Bolsters, Bar Supports, and Spacers:
   1. Size and Shape: To support reinforcement and prevent displacement of reinforcing during concrete placement conditions.
   2. Furnish load-bearing pad on bottom to prevent vapor retarder puncture.
   3. Use precast concrete blocks where reinforcing steel is to be supported over soil.
   4. Use plastic protected bar supports or steel supports with plastic tips where reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use stainless-steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.
   5. Provide #5 minimum size support bars. Do not reposition upper bars in a bar mat for use as support bars.
   6. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

K. Spacing:
   1. Space reinforcement bars with minimum clear spacing according to ACI 350.
   2. If bars are indicated in multiple layers, place upper bars directly above lower bars.

L. Determine clear concrete cover based on exposure to the environment. Provide the following minimum clear concrete cover over reinforcement, unless indicated otherwise:
   1. Concrete cast against and permanently exposed to earth: 3 inches.
   2. All other concrete surfaces: 2 inches.

M. Splicing:
   1. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the

reinforcement subject to direct tension shall be butted and joined with complete penetration welds to develop, in tension, at least 125 percent of the specified yield strength of the bar. Offset splices in adjacent bars the distance of a Class B splice or 30 inches, whichever is greater.

2. Welded Wire Fabric: Provide lap splices in accordance with the requirements of ACI 318 but not less than 12 inches. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.
3. Locate reinforcement splices at point of minimum stress, unless indicated otherwise.

N. Bond and ground reinforcement as specified in Section 260526 - Grounding and Bonding for Electrical Systems.

O. Place dowels for concrete masonry units in accordance with approved placement drawings.

3.2 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Install reinforcement within following tolerances for flexural members, walls, and compression members:
1. Reinforcement Depth Greater Than 8 Inches:
   a. Depth Tolerance: Plus or Minus 3/8 inch.
   b. Concrete Cover Tolerance: Minus 3/8 inch.
2. Reinforcement Depth Less Than or Equal to 8 Inches:
   a. Depth Tolerance: Plus or Minus 1/2 inch.
   b. Concrete Cover Tolerance: Minus 1/2 inch.

3.3 INSPECTION

A. Inspection by Engineer: When reinforcing is complete and ready for inspection, notify Engineer at least six working hours prior to proposed concrete placement.

B. Do not cover reinforcing steel with concrete until reinforcement, including the size, spacing and position has been inspected by the Engineer and the Engineer's release to proceed with concreting has been obtained. Keep forms open until the Engineer has completed inspection of the reinforcement.

END OF SECTION 032000

SECTION 033000 – CAST-IN-PLACE 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: Cast-in-Place Concrete for various items indicated in Contract Documents.

B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Field sampling, testing, inspection and related laboratory tests will be provided by the Owner.

C. Related Requirements:
1. Section 031000 - Concrete Forming and Accessories: Formwork and accessories.
2. Section 032000 - Concrete Reinforcing: Requirements for reinforcing steel and supports.
3. Section 032500 - Concrete Joint and Joint Accessories.
4. Section 033500 - Concrete Finishing: Finishing of concrete floor and wall surfaces.
5. Section 033900 - Concrete Curing: Curing of concrete surfaces.
6. Section 034113.00 - Precast Concrete Hollow Core Planks.
7. Various Sections in Division 07: Preparing concrete surfaces to receive dampproofing and waterproofing.
8. Various Sections in Divisions 21 through 23: Mechanical items for casting into concrete.
9. Various Sections in Division 26: Electrical items for casting into concrete.

1.3 COORDINATION

A. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

1.4 ACTION SUBMITTALS

A. Submit, in accordance with Section 013300, product data for:
1. Sources of cement, fly ash or ground granulated blast furnace slag, aggregates, and batched concrete. Indicate name and address of mill, quarry, or plant.
2. Air entrainment admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.
3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

4. Vapor retarders. Product data including catalogue cut, technical data, storage requirements, and conformity to ASTM standards.
5. Cold weather and hot weather concreting plans demonstrating how concrete will meet the requirements of this Section including but not limited to concrete mixes, placement, curing and protection.

B. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.

C. Samples:
1. Fine and coarse aggregates, if requested for examination by the Engineer.
2. Vapor retarder.

1.5 INFORMATIONAL SUBMITTALS

A. Test Reports:
1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.
2. Cement and fly ash or ground granulated blast furnace slag: Conformance to ASTM standards, including chemical analysis and physical tests.
3. Concrete Mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash or ground granulated blast furnace slag. Provide either subparagraph a. or b., below, for each mix proposed.
   a. Standard deviation data for each proposed concrete mix based on statistical records. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:
      1) Date of sampling and name of testing laboratory.
      2) Name of concrete batch plant.
      3) Water cementitious ratio.
      4) Slump of batch.
      5) Air content of batch.
      6) Compressive strengths of all cylinders tested at that age in that batch.
      7) If available, temperature and unit weight of batch.
      8) Provide data from projects not more strictly controlled than outlined in these specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.
   b. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.

B. Certifications:
1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.
2. Certify admixtures are made for use in concrete in contact with potable water after 30 days of concrete curing.

3. Certify that Contractor is not associated with independent testing laboratory proposed for use by Contractor nor does Contractor or its officers have a beneficial interest in the laboratory.
4. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.
5. Certificate of conformance for concrete production facilities from the NRMCA.
6. Material certification, signed by manufacturer, for vapor retarder.

C. Qualifications:
1. Independent Testing Laboratory:
   a. Name and address
   b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.
   c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.
   d. Names and qualifications of the supervising laboratory technicians.
   e. Statement of conformance provided by evaluation authority defined in ASTM C 1077. Provide report prepared by evaluation authority when requested by the Engineer.
   f. Submit as required above for other organizations that will provide external technical services.

1.6 CLOSEOUT SUBMITTALS

A. Section 017300 - Execution: Requirements for submittals.

B. Project Record Documents: Record actual locations of embedded utilities and components concealed from view in finished construction.

1.7 QUALITY ASSURANCE

A. Comply with ACI 350 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.

B. Independent Testing Laboratory: Meet requirements of ASTM E 329 and ASTM C 1077. Do not use laboratories affiliated and having a beneficial interest with Contractor or its officers.

C. Provide concrete uniform in color and appearance.

D. Preconstruction Meeting: At least 10 working days before first concrete placement, hold a meeting to review concrete placement requirements, vapor-retarder installation, waterstop placement, jointing, concrete curing, hot and cold weather concreting, and finishing. Review, with the attendance of the plasticizer manufacturer, the properties and techniques of batching and placing concrete containing high-range water-reducing admixture. Notify all parties involved, including the Engineer, of the meeting at least 10 working days prior to its scheduled date. Prepare an agenda for the meeting. Take meeting minutes and distribute to meeting attendees.

E. If during work progress, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make ordered changes without additional compensation.

F. If during work progress, materials from the sources originally accepted change in characteristics, make new acceptance tests of materials and establish new concrete mixes with assistance of an independent testing laboratory, without additional compensation.

G. Field testing, inspection services, and related laboratory tests will be provided by Owner. Methods of testing will comply with latest applicable ASTM methods. The following items will be tested by Owner to verify conformity with this Section:

1. Concrete Placements: Compressive strength (cylinders), temperature, slump, and air content.
2. Other materials that may require field testing.

H. Samples of constituents and as-placed concrete will be subjected to laboratory tests by Owner. Materials incorporated in the work shall conform to accepted samples.

I. Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.

J. Perform Work according to ACI 301 and 350).

K. Comply with ACI 305R when placing concrete during hot weather.

L. Comply with ACI 306.1 when placing concrete during cold weather.

M. Acquire cement and aggregate from one source for Work.

1.8 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Maintain concrete temperature after installation at minimum 50 degrees F for minimum seven days.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Vapor Retarder Permeance: Maximum 1 perm when tested according to ASTM E 96, water method.

2.2 MATERIALS

A. Materials shall comply with this Section and any applicable State or local requirements.

B. Cement: Domestic portland cement conforming to ASTM C 150. Do not use air entraining cements. Do not use cement produced by a manufacturer that uses hazardous waste derived fuel as an energy source for its kilns. Cement brand must be approved by the Engineer and one brand shall be used throughout the work.
   1. Comply with ASTM C150, Type II - Moderate Sulfate Resistant.
   2. Type: Portland.

C. Aggregates:
   1. Fine Aggregate: Washed inert natural sand conforming to ASTM C 33.
   2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C 33. Grading requirements are listed in ASTM C 33, Table 3 for the specified coarse aggregate size number listed in Table 1. Limits of deleterious substances and physical property requirements are listed in ASTM C 33, Table 4 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.
   3. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C 1260 and using project proposed cement. If aggregates proposed do not meet this requirement, then satisfy either subparagraph a. or b. below.
      a. Total equivalent alkali content of the cement: Do not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C 150.
      b. Fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C 1260 and using the cement and fly ash or ground granulated blast furnace slag proposed for the project. Proportions of cement-fly ash mix or cement-ground granulated blast furnace slag mix shall be the same as those proposed for the project.

D. Water:
   1. Comply with ACI 318 and ACI 350.
   2. Potable.

E. Admixtures: Use admixtures free of chlorides and alkalis, except for those attributable to drinking water. Provide admixtures from same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with concrete mix including other admixtures and made for use in concrete in contact with potable water after 30 days of concrete curing. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.
   1. Air Entrainment: Comply with ASTM C260.

2. Chemical:
   a. Comply with ASTM C 494.
   b. Type A - Water Reducing.

F. Supplementary Cementitious Materials:
1. Fly Ash: Class F fly ash complying with ASTM C 618, including the requirements of Table 1 but with the Loss on Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.
2. Ground Granulated Blast Furnace Slag: Grade 100 or Grade 120 ground granulated blast furnace slag complying with ASTM C 989. Provide ground granulated blast furnace slag from a single source and uniform in color. Mill test reports submitted must be within 6 months of submittal date.

2.3 CONCRETE MIX

A. Engage an independent testing laboratory to establish concrete mixes and perform sampling and laboratory testing of products and materials.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.

C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.
1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 350 and based on the modification factors for standard deviation tests contained in ACI 350.
2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28-day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. Cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. Resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.

D. Test fly ash or ground granulated blast furnace slag and concrete mixture to provide test data confirming that materials in combination with the cement meet strength requirements and are compatible with other concrete additives.

E. Test aggregates for potential alkali reactivity in accordance with ASTM C 1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3-month intervals.

F. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with compression strength requirements in conformity with the provisions of ACI 318.

G. Entrained Air: Measure by ASTM C 231 as shown in Table 1.
   1. If proposed air entrainment admixture requires testing methods other than ASTM C 231 to accurately determine air content, make special note of this requirement in admixture submittal specified under Paragraph 1.4, A.

H. Concrete Slump: Measure by ASTM C 143 as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 inches to 10 inches.

I. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

TABLE 1

Class	Design Strength 1	Cement 2	Fine Aggregate 3	Coarse Aggregate 3	Cementitious Content 4
A	2500	Type II	Sand	57 (9)	440
E1	4500	Type II	Sand	467	560
E2	4500	Type II	Sand	57	580
E3	4500	Type II	Sand	67	610
F	4000	Type II	Sand	8	600

Class	W/C Ratio 5	SCM 6	AE Range 7	WR 8	HRWR 10	Slump Range Inches
A	0.62 max.	Yes	3.5 to 5	Yes	No	1-4
E1	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
E2	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
E3	0.42 max.	Yes	3.5 to 5	Yes	No	3-5
F	0.44 max	Yes	3.5 to 5	Yes	No	3-5

TABLE NOTES:

1. Minimum compressive strength in psi at 28 days.
2. ASTM designation in ASTM C 150.
3. Size Number in ASTM C 33.
4. Minimum cementitious content in lbs per cubic yard where fly ash or ground granulated blast furnace slag is used cementitious content is defined as cement content plus fly ash or ground granulated blast furnace slag content.
5. W/C is Maximum Water Cementitious ratio by weight.
6. Supplementary Cementitious Material (SCM) fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight. If ground granulated blast furnace slag is used in lieu of fly ash, the content of ground granulated blast furnace slag shall be in the range of 25-45 percent of the total cement plus ground granulated blast furnace slag content, by weight.
7. AE is percent air entrainment.
8. WR is water reducing admixture.
9. Except as specified in Section 260543 for concrete electrical raceway encasement.
10. HRWR is high-range water-reducing admixture.

J. Admixtures:
   1. Include admixture types approved by Engineer and their quantities in concrete mix designs.
   2. Do not use calcium chloride or admixtures containing calcium chloride.
   3. Add air entrainment admixture to all concrete.
   4. Add water reducing admixture to all concrete.

K. Ready-Mixed Concrete: Mix and deliver concrete according to ASTM C94 and ASTM C685.

2.4 ACCESSORIES

A. Vapor Retarder:
   1. Sheet Vapor Retarder, Class A: ASTM E1745, Class A; not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

PART 3 - EXECUTION

3.1 MEASURING MATERIALS

A. Provide concrete composed of portland cement, fly ash or ground granulated blast furnace slag, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 318 and ASTM C 94. Batch all constituents, including admixtures, at the plant.

B. Measure materials for batching concrete by weighing in conformity with and within tolerances given in ASTM C 94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.

C. Weigh cement and fly ash or ground granulated blast furnace slag in individual weigh batchers that are separate and distinct from weigh batchers used for other materials. When cement and fly ash or ground granulated blast furnace slag are weighed in a cumulative weigh batcher, the cement shall be weighed first.

D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record number of gallons of water as-batched on printed batch tickets.

E. Dispense admixtures either manually using calibrated containers or measuring tanks or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
   1. Charge air entrainment and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.
   2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTING

A. Provide ready-mixed concrete produced by equipment complying with ACI 318 and ASTM C 94 and produced by a plant certified by the NRMCA. Do not hand-mix. Use truck mixers carrying a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.

C. Keep water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate water directed to be added by additional mixing of at least

50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.

D. Comply with ACI 318 and ASTM C 94 for central plant and rolling stock equipment and methods.

E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20 feet long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

F. Do not retemper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.

G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.2 I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.

H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash or ground granulated blast furnace slag, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.

I. Temperature and Mixing Time Control:
   1. In cold weather (see Paragraph 3.8, C) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.
   2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.
   3. In hot weather (see Paragraph 3.8, D), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.
   4. Maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the values shown in the following Table 2:

TABLE 2

AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER)	MAXIMUM TIME
(27 Degree C) 80 Degree F to 90 Degree F (32 Degree C)	45 minutes
(21 Degree C) 70 Degree F to 79 Degree F (26 Degree C)	60 minutes
(5 Degree C) 40 Degree F to 69 Degree F (20 Degree C)	90 minutes

5. If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed 90 minutes.

3.3 EXAMINATION

A. Section 017300 - Execution: Requirements for installation examination.

B. Verify requirements for concrete cover over reinforcement.

C. Verify that anchors, seats, plates, reinforcement, piping, electrical conduits and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

D. At all times batch, mix, transport, place, and cure concrete to the inspection of the Engineer. Advise the Engineer of readiness to proceed at least 24 hours prior to each concrete placement. The Engineer will inspect the preparations for concreting, including preparation of previously placed concrete, reinforcing and alignment, cleanliness, and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.

3.4 EMBEDDED ITEMS

A. Secure to forms as required or set for embedment as required, miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.

B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.

C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

D. Do not embed piping in concrete unless indicated on Drawings.

E. Do not embed electrical conduits in concrete unless indicated on Drawings.

F. Fabricate piping and conduit such that cutting, bending, or relocation of reinforcing steel is not required. Satisfy the following for pipes and conduits embedded within a slab or wall (other than those merely passing through), unless otherwise indicated on Drawings or approved:
   1. Maximum outside dimension of pipe or conduit: Be not greater than one third the overall thickness of slab or wall.
   2. Spacing of pipes or conduits: Be greater than or equal to three diameters or widths on center.

G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.

H. Ensure specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

I. Position embedded anchor bolts using templates.

J. Correct embedded items not installed in the location or alignment needed or displaced by concrete placement without additional compensation.

3.5 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Previously Placed Concrete:
   1. Prepare joints as specified in Section 032500 - Concrete Joints and Accessories.

C. Remove debris and ice from formwork, reinforcement, and concrete substrates.

D. Remove water from areas receiving concrete before concrete is placed.

3.6 CONCRETE APPEARANCE

A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Make, at no additional cost to the Owner, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finish ability are observed:
   1. Gradation of aggregate.
   2. Proportion of fine and coarse aggregate.
   3. Percentage of entrained air, within the allowable limits.

B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 033500.

3.7 INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder in accordance with ASTM E1643 and manufacturer's written instructions.
   1. Install vapor retarder with longest dimension parallel with direction of concrete pour.
   2. Face laps away from exposed direction of concrete pour.
   3. Lap vapor retarder over footings and grade beams not less than 6 inches, sealing vapor retarder to concrete.
   4. Lap joints 6 inches and seal with manufacturer's recommended tape.
   5. Terminate vapor retarder at the top of floor slabs, grade beams, and pile caps, sealing entire perimeter to floor slabs, grade beams, foundation walls, or pile caps.

6. Seal penetrations in accordance with vapor retarder manufacturer's instructions.
7. Protect vapor retarder during placement of reinforcement and concrete.
8. Repair damaged areas by patching with vapor retarder material, overlapping damages area by 6 inches on all sides, and sealing to vapor retarder.

B. Placing Concrete:
1. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
   a. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
   b. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.
2. Place concrete according to ACI 301 and 350.
3. Notify testing laboratory and Engineer minimum 24 hours prior to commencement of operations.
4. Ensure that reinforcement, inserts, embedded parts, formed expansion and contraction joints, and are not disturbed during concrete placement.
5. Install vapor retarder under interior slabs on grade according to ASTM E 1643.
6. Lap vapor retarder joints minimum 6 inches and seal watertight by taping edges and ends.
7. Repairs:
   a. Repair vapor retarder damaged during placement of concrete reinforcement.
   b. Using vapor retarder material, lap over damaged areas minimum 6 inches and seal watertight.
8. Verify that formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.
9. Deposit concrete as near its final position as possible to prevent segregation due to rehandling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
10. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, determine slump at point of truck discharge and determine air content at point of placement.
11. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.
12. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.
13. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.
14. Slabs:

a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
b. Avoid delays in placement. If there is a delay in placement, spade and consolidate concrete placed after the delay at the edge of previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep top surface of the wall moist to prevent cold joints.

15. Formed Concrete:
a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes near the surface of concrete already placed. Do not permit concrete to drop freely more than 4 feet. Place concrete for walls in 12 inch to 24 inch lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15 feet; maximum lift thickness not to exceed 7 feet.
16. Bollards: Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.
17. Maintain records of concrete placement, including date, location, quantity, air temperature, and test samples taken.
18. Place floor slabs in indicated checkerboard pattern.

C. Compacting:
1. Consolidate concrete by vibration and puddling, spading, rodding, or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding, and forking along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting, or planes of weakness.
2. Compact concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.
3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18 inches to 30 inches apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.
4. Concrete Slabs: Vibrate concrete slabs less than 8 inch thick by vibrating screeds. Vibrate concrete slabs 8 inches and thicker by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.
5. Walls: Use internal vibrators rather than form vibrators, unless otherwise approved by the Engineer. General: for each vibrator needed to level the batch at the point of discharge, use one or more additional vibrators to densify, homogenize, and perfect the surface. Insert vibrators vertically at regular intervals, through fresh concrete and slightly into the previous lift, if any.
6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:
a. Frequency of vibrator returns to normal.
b. Surface appears liquefied, flattened and glistening.

c. Trapped air ceases to rise.
d. Coarse aggregate has blended into surface but has not disappeared.

3.8 PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Protect finished surfaces and slabs whenever ambient conditions of humidity, temperature, sunlight and wind may result in the rapid evaporation of water from the concrete, to prevent checking and crazing, until the beginning of curing.

C. Cold Weather Concreting:
1. For this Specification, 'cold weather' is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of highest and lowest temperature during the period from midnight to midnight.
2. Batch, deliver, place, cure, and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.
3. Review cold weather concreting plan at preconstruction meeting. Include methods and procedures for use during cold weather including the production, transportation, placement, protection, curing, and temperature monitoring of concrete and procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
4. Maintain minimum temperature of concrete immediately after placement and during the protection period as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Minimum Concrete
Temperatures For
Section Dimensions

Minimum Concrete Temperature:	< 12 inches	12 - 36 inches
	55 degrees F	50 degrees F

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.
   a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete, where 7 days at an average 50 degrees F equals 350 degree-days.
   b. To calculate the weighted average daily air temperature, sum hourly measurements of air temperature in the shade at concrete surface taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.
6. Do not use salt, manure or other chemicals for protection.
7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below

those shown in Table 3 until at least 24 hours after water curing has been terminated and air-dry concrete for at least 3 days prior to first exposure to freezing temperatures.

8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

D. Hot Weather Concreting:

1. For this Specification, 'hot weather' is defined as any combination of high air temperatures, low relative humidity, and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour.
2. Batch, deliver, place, cure, and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.
    a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.
    b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.2 I.4. Provide vibration immediately after placement.
    c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.
3. Review hot weather concreting plan at preconstruction meeting. Include methods and procedures for use during hot weather, including production, placement, and curing.

3.9 REMOVAL OF FORMS

A. Do not remove forms before concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing, whichever is longer.

TABLE 4

Forms for	Degree Days
Slabs	500
Walls and vertical surfaces	100

(See definition of degree-days in Paragraph 3.8C).

B. Do not remove shores until concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and construction live loads.

C. In cold weather when temperature of concrete exceeds ambient air temperature by 20 degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

3.10 INSPECTION AND TESTING

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017300 - Execution: Requirements for testing, adjusting, and balancing.

C. Inspection and Testing: Performed by Owner's testing laboratory according to ACI 318.

D. Provide unrestricted access to Work and cooperate with appointed testing and inspection firm.

E. Submit proposed mix design of each class of concrete to inspection and testing firm for review and approval prior to commencement of Work.

F. Concrete Inspections:
1. Continuous Placement Inspection: Inspect for proper installation procedures.
2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.

G. Strength Test Samples:
1. Sampling Procedures: Comply with ASTM C 172.
2. Cylinder Molding and Curing Procedures:
   a. Comply with ASTM C 31.
   b. Cylinder Specimens: Standard cured.
3. Sample concrete and make one set of five cylinders for every 100 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area for slabs and walls. Form specimens in 6 inch diameter by 12 inch long non-absorbent cylindrical molds.
4. If volume of concrete for a class of concrete would provide less than five sets of cylinders, take samples from five randomly selected batches, or from every batch, if less than five batches are used.
5. Make one additional cylinder during cold weather concreting and field cure.

H. Field Testing:
1. Slump Test Method: Comply with ASTM C 143.
2. Air Content Test Method: Comply with ASTM C 173.
3. Temperature Test Method: Comply with ASTM C 1064.
4. Compressive Strength Concrete:
   a. Measure slump and temperature for each sample. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.
   b. Measure air content in air-entrained concrete for each sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C 231 or by the volumetric method complying with ASTM C 173. If aggregates with high absorptions are used, use the latter test method. When concrete is pumped, air content will be determined at point of placement.

I. Cooperate in the making of tests by allowing free access to the work for the selection of samples. Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to Owner's testing lab. Protect the specimens against injury or loss through construction operations. Furnish material and labor required for purpose of taking concrete cylinder samples. Owner will pay for shipping of specimens.

J. Cylinder Compressive Strength Testing:

1. Test Method: Comply with ASTM C 39.
2. Test Acceptance: According to ACI 318.
3. Test one cylinder at seven days.
4. Test one cylinder at fourteen days.
5. Test two cylinders at 28 days.
6. Retain one cylinder for 56 days for testing when requested by Engineer.
7. Dispose of remaining cylinders if testing is not required.
8. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum seven-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths without additional compensation.

K. Core Compressive Strength Testing:
1. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. Use results of tests on such cores as basis for acceptance, rejection, or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve Contractor from meeting specification requirements. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Repair core holes with non-shrink grout as specified in Section 036000 - Grouting. Work of cutting, testing, and repairing the cores will be at the expense of Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of Owner.
2. Sampling and Testing Procedures: Comply with ASTM C 42.
3. Test Acceptance: According to ACI 318.
4. Drill three cores for each failed strength test from failed concrete.

L. Patching:
1. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
2. It is the intent of these Specifications to require quality work including forming, mixing, and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.
3. As soon as forms have been stripped and concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.
4. Immediately after removal of forms, remove tie cones and metal portions of ties as specified in Section 031000 - Concrete Forming and Accessories. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16 inch brush coat of neat cement slurry mixed to consistency of a heavy paste. Immediately plug hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.
5. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days as necessary to bring surface down with parent concrete. Do not damage or

stain virgin skin of surrounding parent concrete. Wash thoroughly to remove rubbed matter.

6. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

Material	Volumes	Weights
Cement	1.0	1.0
Sand	1.0	1.0
Pea Gravel	1.5	1.5

7. Patch imperfections as directed by Engineer.
8. Defective concrete and honeycombed areas: Chip down square and at least 1 inch 1-in deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8 inch wide around the steel. For areas less than 1-1/2 inches deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2 inch layers on successive days, each layer being applied with slurry as described above.

M. Defective Concrete:
1. Description: Concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.
2. Repair or replacement of defective concrete will be determined by Engineer.
3. Do not patch, fill, touch up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

3.11 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.8E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table 1. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation. In such cases of failure to meet strength requirements, Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C 94. The "purchaser" referred to in ASTM C 94 is the Contractor.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C 42 and C 39. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, and walls in which such concrete was used. Test need not be made until

concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Perform coring and testing, load tests, and any strengthening or concrete replacement required because strengths of test specimens are below that specified, without additional compensation.

C. Should the strength of test cylinders fall below 60 percent of required minimum 28 day strength, concrete shall be rejected, removed, and replaced without additional compensation.

3.12 SCHEDULE

A. Following Table 5 are general applications for various concrete classes and design strengths:

TABLE 5

Class	Design Strength (psi)	Description
A	2,500	Concrete fill, concrete fill for bollards, electrical raceway encasement and pipe encasement.
E1	4,500	Structural concrete foundation mats and slabs, walls, and footings 16 inches and greater in thickness.
E2	4,500	Except as noted above for Class E1 concrete: Structural concrete greater than 10 inches in thickness including walls, slabs on grade, elevated slab and all other structural concrete greater than 10 inches in thickness.
E3	4,500	Structural concrete 10 inches or less in thickness including walls, slabs on grade, elevated slab and all other structural concrete 10 inches or less in thickness.
F	4,000	Topping for precast concrete hollow core planks.

END OF SECTION 033000

SECTION 033053.13 - CAST-IN-PLACE CONCRETE FOR UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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; concrete and reinforcement for encasement of underground ducts and raceways for electrical systems.

B. Related Requirements:
   1. Section 033000 “Cast-in-Place Concrete” for concrete and deformed reinforcing bars and waterstops to be used in electrical ductbank and raceway systems.
   2. Section 260543 "Underground Ducts and Raceways for Electrical Systems " for electrical component related to ductwork and raceway systems.
   3. Section 312333.13 "Earthwork Components of Underground Ducts and Raceways for Electrical Systems " for earthwork related to ductwork and raceway systems.

1.3 ACTION SUBMITTALS

A. Submit reinforcement under Section 032000 “Concrete Reinforcing.”

B. Submit concrete mix design under Section 033000 “Cast-in-Place Concrete.”

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Concrete: Comply with Section 033000 “Cast-In-Place Concrete,” except as follows:
   1. Maximum Coarse-Aggregate Size: aggregate size shall not exceed 3/8-in.
   2. Minimum Compressive Strength: 2500 psi at 28 days.
   3. Maximum water / cement ratio: 0.62.
   4. Color: Red dye added to concrete during batching. The concrete shall be dyed red throughout the concrete; surface treatment will not be accepted. Provide colorant consisting of an integral red-oxide coloring pigment in the proportion of 8 pounds per cubic yard of concrete. The costs, if any, of cleaning coloring pigment from the concrete delivery and handling equipment and other related cleanings shall be considered as part of the work.

2.2 STEEL REINFORCEMENT MATERIALS

A. Comply with Section 032000 “Concrete Reinforcing.”

PART 3 - EXECUTION

3.1 CONCRETE AND REINFORCING INSTALLATION

A. Concrete-Encased Ducts and Duct Bank:
   1. Reinforcement: Reinforce all concrete-encased duct where indicated. Arrange reinforcing bars and ties without forming conductive or magnetic loops around ducts or duct groups.
      a. Comply with requirements of Section 033000 “Cast-in-Place Concrete.”
   2. Forms: Form as specified in Section 033000 “Cast-in-Place Concrete.”
   3. Concrete Cover: Provide not less than 4-in of concrete between the outside of a duct or raceway and the earth. Provide not less than 2-in of concrete between adjacent ducts or raceways.
   4. Concreting Sequence: Place each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the placement. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
      b. If more than one placement is necessary, terminate each placement in a vertical plane and provide construction joint as indicated.
   5. Placing Concrete: Comply with requirements Section 033000 "Cast-in-Place Concrete," PART 3. Place concrete carefully during placements to prevent voids under and between duct or raceway and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts or raceways. Allow concrete to flow around duct or raceway and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
   6. Where ductbanks pass through concrete walls, extend concrete encasement through walls and finish flush with inside surfaces. Provide watertight construction joints with waterstops conforming to Section 033000 “Cast-in-Place Concrete.”

3.2 EXAMINATION

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

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

END OF SECTION 033053.13

SECTION 033500 - CONCRETE FINISHING

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. Finishing of concrete.
   2. Floor surface treatment.

B. Related Requirements:
   1. Section 031000 - Concrete Forming and Accessories: Cast-in-place concrete formwork, form ties and form release agent.
   2. Section 031500 - Concrete Joints and Accessories: Waterstops, premolded joint filler, sealant and neoprene bearing pads.
   3. Section 033000 - Cast-in-Place Concrete: Cast-in-place concrete.
   4. Section 033900 - Concrete Curing: Procedures for curing horizontal and vertical concrete surfaces.

1.3 COORDINATION

A. Coordinate Work of this Section with concrete placement and concrete curing.

1.4 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information on curing compounds, curing papers, slip-resistant treatment, compatibilities, and limitations.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

C. Qualifications Statements:
   1. Submit qualifications for manufacturer and applicator.
   2. Submit manufacturer's approval of applicator.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures: Requirements for submittals.

B. Operation and Maintenance Data: Submit information on maintenance renewal of applied coatings.

1.7 QUALITY ASSURANCE

A. Perform Work according to ACI 301 and 302.1.

B. Maintain one copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

B. Applicator: Company specializing in performing Work of this Section with minimum three years' experience and approved by manufacturer.

1.9 RESPONSIBILITY FOR CHANGING FINISHES

A. The surface finishes specified for concrete to receive coatings or other finish materials are those required for the proper application of the products specified under other Sections. Where products different from those specified are approved for use, determine if changes in finishes are required and provide the proper finishes to receive these products.

B. Perform changes in finishes made to accommodate products different from those specified at no additional compensation. Submit proposed new finishes to the Engineer for approval.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.11 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Temporary Heat: Maintain minimum ambient temperature of 50 deg. F.

C. Ventilation: Sufficient to prevent injurious gases from temporary heat or other sources from affecting personnel or concrete.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that floor surfaces are acceptable to receive Work of this Section.

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

3.2 FORMED SURFACES

A. Form Removal: Conform to Sections 031000 and 033000.

B. Clean exposed concrete surfaces and adjoining work stained by leakage of concrete.

C. Off-Form Finish:
1. Remove fins and other projections and fill tie cones and defects as specified in Section 033000 “Cast-In-Place Concrete.”

D. Rubbed Finish:
1. Immediately upon stripping forms and before concrete changes color, carefully remove fins with a hammer. While surface is still damp apply a thin coat of medium consistency neat cement slurry using bristle brushes to provide a bonding coat within pits, air holes or blemishes in parent concrete. Do not coat large areas of the surface with this slurry.
2. Before slurry dries or changes color, apply a dry (almost crumbly) grout consisting of one volume cement to 1-1/2 volumes of clean masonry sand having a fineness modulus of approximately 2.25 and complying with gradation requirements of ASTM C 144. Apply grout uniformly using damp (neither dripping wet nor dry) pads of coarse burlap approximately 6-inch square used as a float. Scrub grout into pits and air holes to provide a dense mortar in concrete imperfections to be patched.
3. Allow mortar to partially harden for one or two hours depending upon weather. If the air is hot and dry, keep surface damp during this period using a fine, fog spray. When grout has hardened sufficiently so it can be scraped from the surface with perpendicular edge of a steel trowel without damaging the grout in small pits or holes, cut off grout that can be removed with a trowel. Grout allowed to remain on surface too long will get too hard and will be difficult to remove.

4. Allow the surface to dry and rub it vigorously with clean dry burlap to completely remove dried grout. No visible film of grout should remain after this rubbing. Entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow grout to dry after it has been cut off with trowel so it can be wiped off clean with the burlap.
5. On the day following repair of pits, air holes, and blemishes, wipe surfaces clean with dry, used pieces of burlap containing old hardened mortar, which will act as a mild abrasive. After this treatment, there should be no built-up film remaining on the parent surface; if however, a built-up film remains, use a fine abrasive stone to remove such material without breaking through original concrete surface film. Scrub lightly to remove excess material without working up a lather or mortar or changing concrete texture.
6. Follow final bagging or stoning operation with a thorough wash-down with stiff bristle brushes to remove extraneous materials from the surface. Spray surface with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after repair grout application.
7. Rubbed Finish application may be deleted by the Engineer if unfinished concrete surface is of superior quality and without surface voids.

E. Abrasive Blast Finish:
1. Coordinate with Rubbed Finish application. Do not begin until materials applied during Rubbed Finish operation have cured or before concrete has reached minimum 7-day strength. Apply abrasive blast finish only where indicated on Contract Documents.
2. Prepare a sample area of minimum 4 feet high by 16 feet wide Blast Finish as directed by Engineer on a portion of new wall construction which will not be exposed in the final work. Sample area shall contain a variety of finishes obtained with different nozzles, nozzle pressures, grit materials, and blasting techniques for selection by Engineer. Leave final accepted sample exposed until completion of all Blast Finish operations.
3. Perform Blast Finish operations meet regulatory agency requirements. Obtain required permits or licenses to perform the work.
4. Perform abrasive blast finishing in as continuous an operation as possible, utilizing same work crew to maintain continuity of finish on each surface or area of work. Maintain patterns or variances in depths of blast as present on the accepted sample.
5. Use an abrasive grit of proper type and gradation, as well as equipment and technique to expose aggregate and surrounding matrix surfaces as follows:
   a. Medium: Generally expose coarse aggregate to a 1/4 inch to 3/8 inch reveal.
6. Abrasive blast corners and edge of patterns carefully, using back-up boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure and blasting techniques required to match the approved mock-up.
7. Upon completion of Blast Finish operation, thoroughly flush finished surfaces with clean clear water to remove residual dust and grit.

3.3 FLOORS AND SLABS

A. Consider the potential for longer setting time in concrete containing fly ash or ground granulated blast furnace slag.

B. Compact with internal vibrators as specified in Section 033000 “Cast-In-Place Concrete” and screed to established grades.

C. Following screeding as specified above, float slabs as approved by the Engineer. Continue floating operation until sufficient mortar is brought to surface to fill voids. Test surfaces with a straightedge to detect and eliminate high and low spots. Do not overwork concrete as evidenced by excess water and fine material on its surface.

D. Do not use "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate away from the surface and allowing a layer of mortar to accumulate on any slab finish. Do not dust surfaces with dry materials. Round off edges of slabs and tops of walls with a steel edging tool. Use steel edging tool with radius of 1/4 inch for slabs subject to wheeled traffic.

E. Measure floor flatness the day after a concrete floor is finished and before the shoring is removed, in order to eliminate any effects of shrinkage, curling, and deflection.

F. Finish Descriptions:
   1. Steel Trowel Finish:
      a. Finish by screeding and floating with straightedges to bring the surfaces to indicated elevations. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float surface to a true and even plane with no coarse aggregate visible.
      b. Apply sufficient pressure on wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks.
      c. Trowel the surface again for the purpose of burnishing. Final troweling shall produce a ringing sound from the trowel.
      d. Do not use dry cement or additional water in troweling.
   2. Wood Float Finish:
      a. Finish by screeding with straightedges to bring the surfaces to indicated elevations.
      b. Use a wood float to compact and seal surface. Remove laitance and leave a clean surface.
   3. Light Broomed Finish:
      a. Steel trowel finish, as specified above, but omit final troweling and finish by drawing a fine-hair broom lightly across concrete surface.
      b. Broom in direction and parallel to expansion joints, or in the case of inclined slabs, perpendicular to slope or as directed otherwise.
   4. Broomed Finish:
      a. Steel trowel finish, as specified above, but omit the final troweling
      b. While the concrete is still soft enough, finish the surface with a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the Engineer.
   5. Power Machine Finish:
      a. In lieu of hand steel trowel finishing, use an approved power machine for finishing concrete floors and slabs in accordance with directions of machine manufacturer and as approved by the Engineer.
      b. Do not use a power machine until the concrete has attained necessary set to allow finishing without introducing high and low spots in the slab.
      c. Hand steel trowel those areas of slabs not accessible to power equipment. Provide a final steel troweling done by hand over all areas.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Provide floors and slabs level with a tolerance of 1/8 inch when checked with a 12 feet straightedge, except where drains occur, in which case pitch floors to drains as indicated. When either of above criteria are not met, remove, grind, or make other corrections as directed by the Engineer, at no additional compensation.

C. Measure floor flatness the day after a concrete floor is finished and before shoring is removed, in order to eliminate any effects of shrinkage, curling, and deflection. Support a 12 feet long straightedge at each end with steel gauge blocks whose thickness are equal to tolerance specified. Have no floor surface crowns so high as to prevent a 12 feet straightedge from resting on two end blocks, or low spots so that a third block of twice the tolerance in thickness can pass under the supported straightedge. Compliance with designated limits in four of five consecutive measurements will confirm compliance, unless obvious faults are observed. Make a check for adequate slope and drainage to confirm compliance.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Acceptance:
   1. Areas requiring corrective Work will be identified by Engineer.
   2. Correct defects in defined floor or slab by grinding or removal and replacement of defective Work.
   3. Remeasure corrected areas by procedure as specified in TOLERANCES Article.

3.6 SCHEDULE OF FINISHES

A. Finish concrete in various specified manners either to remain as natural concrete or to receive an additional applied finish or material under another Section. Where products different from those specified are approved for use, comply with requirements of PART 1 Article entitled “Responsibility for Changing Finishes.”

B. Finish base concrete for following grouped conditions as scheduled in following Paragraphs and as further specified in this Section.

C. Exposed Exterior Concrete:
   1. Concrete for exterior on horizontal areas: Broomed finish, non-slip.
   2. Tops of curbs and pads: Steel trowel finish.

D. Exposed Interior Concrete:
   1. Exposed interior concrete including underside slabs, walls, and sides of openings: Rubbed finish.
   2. Concrete for interior walking surfaces, excluding stairs: Wood float finish.

E. Concrete Associated with Structures:

1. Exposed exterior concrete excluding slabs and walking surfaces: Rubbed finish. Rub open tank walls above and to 1 foot below normal water line.
2. Walls of open topped tanks: Rubbed finish above and to 1 foot below normal water line. Off-form finish from 1 foot below normal water line to base of wall.
3. Concrete on which liquids flow or are contained: Steel troweled finish.

F. Concrete to Receive Additional Finishes or Coatings:
1. Concrete to receive dampproofing: Off-form finish.
2. Concrete to receive paint: Rubbed finish.
3. Concrete to receive seamless flooring: Once-over steel trowel finish.
4. Concrete to receive ceramic and quarry tile: Broomed finish as approved.
5. Concrete to receive vinyl and rubber surfacing and carpet: Steel trowel finish.
6. Concrete to receive rubberized asphalt sheet membrane waterproofing: Wood float finish at horizontal surfaces, rubbed finish at vertical surfaces.
7. Concrete to receive roof insulation: Consolidate, screed and wood float to required grades.

G. Miscellaneous Concrete:
1. Concrete not exposed in finished work and not scheduled to receive an additional applied finish or material: Off-form finish at vertical surfaces, consolidate and screed to grade at horizontal surfaces.

END OF SECTION 033500

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SECTION 033900 - CONCRETE CURING

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: Initial and final curing of horizontal and vertical concrete surfaces.

B. Related Requirements:
   1. Section 033000 - Cast-in-Place Concrete: Coordinate Work of this Section with concrete placement, including Hot and Cold Weather and other environmental factors affecting concreting procedures.
   2. Section 033500 - Concrete Finishing: Surface finishing of concrete slabs and walls.

1.3 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's information on curing compounds, mats, paper, sheets, and film, including compatibilities and limitations.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

C. Qualifications Statement:
   1. Submit qualifications for manufacturer.

D. Certifications:
   1. Certify curing compound is suitable for use in contact with potable water after 30 days and is non-toxic and free of taste or odor.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Manufacturer's Certificate:
   1. Certify that products meet or exceed specified sustainable design requirements.
   2. Materials Resources Certificates:

a. Certify recycled material content for recycled content products.
b. Certify source for regional materials and distance from Project Site.

B. Product Cost Data:
1. Submit cost of products to verify compliance with Project sustainable design requirements.
2. Exclude cost of labor and equipment to install products.
3. Provide cost data for following products:
a. Products with recycled material content.
b. Regional products.

1.6 QUALITY ASSURANCE

A. Perform Work according to ACI 301, 302.1, 308.1 and 350.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Membrane-Curing Compound:
1. Comply with ASTM C 309, Type 1D, containing no wax, paraffin or oil and be non-yellowing.
2. Comply with Federal, State and local VOC limits.

B. Absorptive Mats:
1. Description:
a. Material: Burlap-polyethylene (PE).
b. Minimum Weight: 9 oz./sq. yd.

c. Bonded to prevent separation during handling and placing.

C. Sheet Material:
1. Description: Curing paper treated to prevent separation during handling and placing.
2. Comply with ASTM C 171.
3. Color: White.

D. Water: Potable; not detrimental to concrete.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Requirements for application examination.

B. Verify that substrate surfaces are ready to be cured.

3.2 APPLICATION

A. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 degrees F at concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:
1. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling, or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit concrete surface to dry out at any time during curing period. Provide temperature of curing water within 20 degrees F of concrete temperature.
2. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.
3. Membrane Curing: Apply over entire concrete surface except as follows.
a. Do not apply curing compound on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where concrete finish requires an integral floor product.
b. Apply curing compound as soon as free water on the surface has disappeared and no water sheen is visible.
c. Do not apply after the concrete is dry or when curing compound can be absorbed into the concrete. Apply in compliance with manufacturer's recommendations.

B. Specified Applications of Curing Methods:
1. Slabs on Grade and Footings (not used to retain liquids): Water cure or sheet material cure or membrane cure.
2. Structural Slabs (other than Liquid Retaining Structures): Water cure or membrane cure.
3. Horizontal Surfaces which will Receive Additional Concrete, Waterproofing, Coatings, Grout or Other Material that Requires Bond to the substrate: Water cure.
4. Formed Surfaces:
a. No curing, if nonabsorbent forms are left in place seven days.
b. Water cure if absorbent forms are used.

c. Water cure if forms are removed prior to seven days.
d. Water cure exposed horizontal surfaces of formed walls for seven days or until next placement of concrete is made.

5. Surfaces of Concrete Joints: Water cure or sheet material cure.

C. Protect finished surfaces and slabs whenever ambient conditions of humidity, temperature, sunlight and wind may result in the rapid evaporation of water from the concrete, to prevent checking and crazing, until the beginning of curing.

3.3 PROTECTION

A. Section 017300 - Execution: Requirements for protecting finished Work.

B. Do not permit traffic over unprotected surfaces.

C. Reference Section 033000 “Cast-In-Place Concrete” for additional protection requirements.

END OF SECTION 033900

SECTION 034113 - PRECAST CONCRETE HOLLOW CORE PLANKS

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 prestressed concrete hollow core planks.
2. Furnish reinforcing, to be installed in concrete under Section 032000.
3. Erection, including all shimming, and removal of lifting.
4. Grouting between precast concrete hollow core planks, and as indicated.
5. Concrete topping.

B. Related Requirements:
1. Section 033000 - Cast-in-Place Concrete: Concrete.
2. Section 032000 Concrete Reinforcing.
3. Section 042000 Unit Masonry.

1.3 COORDINATION

A. Coordinate Work of this Section with framing components directly associated with Work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Convene minimum one week prior to commencing Work of this Section.

B. Discuss erection procedures and cautions regarding cutting or core drilling.

1.5 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit standard component configuration, design loads, deflections, camber, bearing requirements, and fire ratings.

C. Shop Drawings: Fabrication and erection drawings. Indicate plank layout, plank locations, fabrication details, unit identification marks, reinforcement, connection details, edge conditions, bearing requirements, support conditions, dimensions, and relationship to adjacent materials.

D. Samples: Submit two samples, 12 by 12 by 2 inches long, of exposed-to-view surface finish.

1.6 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification with AWS D1.1 or D1.4, as applicable, within previous 12 months.

C. Delegated Design Submittals: Submit certification of delegated design as required by Division 00 and Division 01, including signed and sealed Shop Drawings with design calculations and assumptions for loadings of planks, prestressing, and related system components.

D. Manufacturer Instructions: Submit special procedures, perimeter conditions requiring special attention.

E. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statements:
   1. Submit qualifications for manufacturer, erector, welders, and licensed professional.
      a. Copy of PCI Plant Certification for manufacturer.
      b. Copy of PCI Certificate of Compliance for erector.
   2. Test reports for tests performed in accordance with PCI MNL-116.
   3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M, AWS B2.1/2.1M, and AWS D1.4/D1.4M.

H. Do not fabricate members until shop drawings and calculations are approved.

1.7 QUALITY ASSURANCE

A. Design planks according to following:
   1. PCI MNL-126.
   2. ACI 318.
   3. ACI 301.

B. Design connections according to PCI MNL-123.

C. Plank Production:
   1. Comply with PCI MNL-116.
   2. Maintain plant records and quality-control program during production of precast planks.
   3. Make records available upon request of Engineer.

D. Maintain one copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in fabricating products specified in this Section with minimum three years' experience. Manufacture all precast concrete hollow core planks at an existing plant certified at the time of bidding by the Precast/Prestressed Concrete Institute Plant Certification Program. Certification is required in the following product groups and categories: C2 Prestressed Hollow-Core and Repetitive Products.

B. Erector: Company specializing in performing Work of this Section with minimum three years' experience. Install all precast concrete hollow core planks by an erector qualified at the time of bidding as evidenced by PCI's Certificate of Compliance to erect Category S1 Simple Structural Systems.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in Commonwealth of Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Transport, store, and handle precast concrete hollow core planks to protect from cracking, distortion, warping, staining, and other damage and in accordance with the manufacturers' instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.
3. Protect members to prevent staining, chipping, or spalling of concrete.

E. Handling:
1. Handle precast members in position consistent with their shape and design.
2. Lift and support only from designated support points.
3. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
4. Mark each member with date of production and final position in structure.

F. Repair or replace damaged units without additional compensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Conform to ACI 318.

B. Member sizes: as indicated. Provide a minimum of 1-1/4 inch of clear concrete cover for all primary reinforcing, bar or prestressing strand. Fabricate precast concrete hollow core planks having shear keyways on the sides that are adjacent to other members to permit grouting between adjacent members.

C. Design precast concrete hollow core planks and connections to support the following loads:
   1. Self-weight.
   2. Weight of concrete topping at a density of 150 lbs/cu.ft. to indicated thicknesses.
   3. Concentrated dead loads (weight of partitions, equipment and other permanent construction supported by precast concrete hollow core planks) as indicated.
   4. Uniformly distributed dead loads (weight of ceilings, equipment and other permanent construction supported by precast concrete hollow core planks) as indicated.
   5. Live load as indicated.
   6. Other loads indicated.
   7. Seismic Loads:
      a. Design and detail elements and connections to resist seismic force according to Building Code requirements and ACI 318 for following:
         1) Spectral Response Acceleration, Short Period (Ss): 0.09.
         2) Spectral Response Acceleration, 1-Second Period (S1): 0.04.
         3) Site Class: D.
         4) Seismic Importance Factor: 1.50.
         5) Seismic Design Category: A
   8. Wind Loads.
      a. Design and detail elements and connections to resist seismic force according to Building Code requirements and ACI 318 for following:
         1) Basic Wind Speed: 120 mph
         2) Exposure Category: B

D. Design components to withstand dead and live loads in a restrained condition as follows:
   1. Dead Loads:
      a. Floor Assembly: self weight.
   2. Live Loads: 20 psf.
   3. Concentrated Loads: 300 lbs.
   4. Horizontal Loads: 50 plf.

   Maximum Allowable Live Load Deflection of Floor Planks: 1/240.

E. Design components to accommodate construction tolerances, deflection of other building structural members, and clearances of intended openings.

F. Grouted Keys: Capable of transmitting horizontal shear force of 2,000 lb./ft.

2.2 MANUFACTURERS

A. Furnish materials according to Performance and Design Standards.

2.3 MATERIALS

A. Obtain all cement, sand and gravel used in precast concrete hollow core planks, including for patching members, from one single source to provide a uniform color and texture.

B. Cement:
   1. Comply with ASTM C 150/C 150M, Type III.
   2. Type: Portland.
   3. Color: White.

C. Aggregate, Sand, Water, Admixtures:
   1. Sand and gravel conforming to ASTM C 33. Size of coarse aggregate to meet spacing requirements of prestressing steel and reinforcing steel. Maximum size of coarse aggregate no larger than 1 inch.
   2. Water reducing admixture in accordance with ASTM C 494.
   3. Air entraining admixture in accordance with ASTM C 260.
   4. As determined by precast manufacturer.
   5. As appropriate to design requirements and PCI MNL-116.

D. Tensioning Steel Tendons:
   1. Prestressing Strand: Uncoated seven wire low relaxation strand conforming to ASTM A 416 Grade 250K.
   2. Comply with ASTM A 416/A 416M, Grade 250.
   3. Diameter: Appropriate to member design.

E. Deformed Reinforcement:
   1. Description: Steel bars.
   2. Comply with Section 032000 Concrete Reinforcing.
   3. Deformed Concrete Reinforcing Bars indicated to be Field Bent or Welded: ASTM A 706.

F. Non-Shrink Grout:
   1. Type: Nonmetallic.
   2. Non-Shrink Cementitious Grout: As specified in Section 036000 and as approved.

G. Cement Grout: Minimum compressive strength of 3,000 psi at 28 days.

2.4 CONCRETE MIXES

A. Provide concrete for all precast concrete hollow core planks having a minimum 28-day compressive strength of 5,000 psi as determined by cylinder tests in accordance with ASTM C 39.

B. Unless otherwise approved by the Engineer, provide concrete having a minimum compressive strength of 3,500 psi at transfer of prestressing force, as determined by cylinder tests in accordance with ASTM C 39.

C. Maximum water-cementitious materials ratio, by weight, 0.45. Minimum cementitious content 470 lbs./cu.yd.

D. Provide concrete mixes having a water reducing admixture and an air entraining admixture, each at a rate in accordance with manufacturers' recommendations.

E. Do not use admixtures containing chlorides.

F. Concrete Topping: Class F concrete as specified in and conforming to requirements of Section 033000 - Cast-In-Place Concrete, except as modified herein.

2.5 FABRICATION

A. Planks:
   1. Description: Plant cast, prestressed, hollow core.
   2. Comply with PCI MNL-126 and ACI 318.

B. Dimensions: As indicated on Drawings.

C. Maintain plant records and quality-control program during production of precast members and make records available upon request of Engineer.

D. Provide a minimum 1/2 inch chamfer at exposed corners.

E. Set all reinforcing, required by the various trades or as indicated, located, and detailed on final approved shop drawings. Prevent displacement during concreting. Correct any omission or change in location or details indicated or required by the various trades as a result of the Contractor's actions without additional Compensation.

F. Welding:
   1. Reinforcing Steel: Comply with AWS D1.4/D1.4M.
   2. Do not tack-weld reinforcing.

G. Place concrete continuously without joints for each precast concrete hollow core plank.

H. Coat ends of strands with bituminous or asphaltic dampproofing materials.

I. Exposed Ends at Stressing Tendons: Fill recess with nonshrink grout and trowel flush.

J. Plant Finish: Comply with PCI MNL-116, commercial grade.

K. Provide a raked finish at top surfaces of members to be covered with concrete topping.

L. Tolerances:
   1. Conform to PCI MNL-126.

2.6 ACCESSORIES

A. Connecting and Supporting Devices:
   1. Materials: Type 316 stainless steel, ASTM A 666, unless otherwise noted.
   2. Welded plates: Carbon steel, ASTM A 36; prime painted.

B. Anchorage Devices for Mechanical and Electrical Equipment Hangers: As specified in the appropriate equipment Section.

C. Bearing Pads:
   1. Multi-monomer plastic bearing strips manufactured specifically for bearing purposes and as approved.

2.7 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Inspection and Testing:
   1. Testing of Concrete Materials and Mix Designs: As specified in Section 033000 - Cast-in-Place Concrete.
   2. Inspect and test stressing tendons before delivery for compliance with indicated standards.

C. Owner Inspection:
   1. Make completed unit available for inspection at manufacturer's factory prior to packaging for shipment.
   2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:
   1. Allow witnessing of factory inspections and test at manufacturer's test facility.
   2. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 0173000 - Execution: Requirements for installation examination.

B. Verify that Site conditions are ready to receive Work.

C. Verify that field measurements are as indicated on Shop Drawings.

D. Verify supporting structure is ready to receive Work.

3.2 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Prepare support equipment for erection procedure, temporary bracing, and induced loads during erection.

3.3 ERECTION

A. Erect members without damage to structural capacity, shape, or finish; replace or repair damaged members.

B. Align and maintain uniform horizontal and end joints as erection progresses.

C. Temporary Bracing and Support:
1. Maintain temporary bracing in place until final connections are made.
2. Protect members from staining.
3. Provide temporary lateral support to prevent bowing, twisting, or warping of members.

D. Install bearing pads at bearing ends of planks as indicated on Drawings. Provide minimum bearing of as indicated.

E. Adjust differential camber between precast members to indicated tolerance before final attachment and grouting.

F. Adjust differential elevation between precast members to indicated tolerance before final attachment.

G. Welding:
1. Comply with AWS D1.1/D1.1M and AWS D1.4/D1.4M.
2. Do not tack-weld reinforcing.

H. Tape-seal underside of plank joints to prevent grout leakage.

I. Joint keys: Clean out and completely fill longitudinal keys and spaces between precast concrete hollow core planks with approved non-shrink cementitious grout. Remove grout that seeps to soffit before it hardens.

J. Adjoining Planks:
1. Make plank-to-plank joints smooth using grout, troweled smooth.
2. Transition differential elevation of adjoining planks with grout to maximum slope of 1:12.

K. Plank ends: Grout plank ends where indicated. Clean out, provide grout stops, and completely fill voids with grout.

L. Do not cut or drill holes in the field, except as shown on approved shop drawings, without written approval of the Engineer. Do not cut prestressing strands.

M. Clean top surface of precast concrete hollow core planks before placing concrete topping. Remove debris, dirt, laitance, oil, grease, and other bond inhibiting materials from the surface

by dry mechanical means such as sandblasting, chipping, or wire brushing. Clean surface of loose or weakened material and dust by dry mechanical means such as sandblasting, vacuuming and airblasting. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded into parent concrete.

N. After top surface has been cleaned, saturate with water and maintain saturation for a period of at least 12 hours. Protect area and equipment below from dripping water. Brush on a 1/16 inch layer of cement and water mixed to the consistency of a heavy paste. Place concrete topping immediately after application of cement paste.

O. Place concrete topping to the limits indicated. Place to the minimum depth as indicated. Consolidate as specified in Section 033000 - Cast-In-Place Concrete and finish as specified in Section 033500 - Concrete Finishing.

3.4 ATTACHMENT OF ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENTS AND SYSTEMS

A. Make attachments at embedded weld plates provided by manufacturer of precast concrete hollow core planks.

B. Make attachments to precast concrete hollow core planks only at the center of the hollow core using drilled bolts (through bolts with nuts and plate washers, adhesive anchors, or toggle bolts). Do not make attachments in the areas between hollow cores.

C. Do not use powder actuated (‘shot’) fasteners for attachment to precast concrete hollow core planks.

3.5 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Erect members level and plumb within allowable tolerances according to PCI MNL-126.

3.6 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

3.7 CLEANING

A. Section 017300 - Execution: Requirements for cleaning.

B. Clean weld marks, dirt, or blemishes from surfaces of exposed members.

3.8 PROTECTION

A. Section 017300 - Execution: Requirements for protecting finished Work.

B. Protect members from damage caused by field welding or erection operations.

C. Use noncombustible shields during welding operations to protect adjacent Work.

END OF SECTION 034113

SECTION 036000 - GROUTING

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. Nonshrink cementitious grout.

B. Related Requirements:
   1. Section 031000 - Concrete Forming and Accessories.
   2. Section 033000 - Cast-in-Place Concrete.
   3. Section 033200 - Concrete Reinforcing.
   4. Section 042000 - Unit Masonry: Masonry grout.
   5. Section 055000 - Metal Fabrications: Grout related to miscellaneous metals.

1.3 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding grout and surface preparation, mixing and installation.
   1. Commercially manufactured nonshrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, and conformity to the specified ASTM standards.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Manufacturer Instructions: Submit instructions for mixing, handling, surface preparation, and placing of nonshrink grouts.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

A. Perform Work according to indicated standards.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' experience in production and use of provided grouts.

B. Pre-installation Meeting: At least ten working days before grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Notify all parties involved with grouting, including the Engineer, of the meeting at least ten working days prior to its scheduled date.

C. Services of Manufacturer's Representative: Provide services of a field technician of the grout manufacturer who has performed at least five projects of similar size and complexity during the last five years, to attend the pre-installation meeting, to be present for the initial installation of each type of grout, and to correct installation problems.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer’s recommended storage time, whichever is less.

D. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material.

E. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location.
   2. Provide additional protection according to manufacturer instructions.

1.8 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Maximum Conditions: Do not perform grouting if temperatures exceed 90 degrees F.

C. Minimum Conditions: Do not perform grouting if the minimum temperature of base plates, supporting concrete and grout are less than 40 degrees F. Maintain minimum temperature of 40 degrees F before, during, and after grouting, until grout has set.

PART 2 - PRODUCTS

2.1 NONSHRINK CEMENTITIOUS GROUT

A. Description:
1. Pre-mixed and ready-for-use formulation requiring only addition of water.
2. Nonshrink, non-corrosive, nonmetallic, non-gas forming, not containing expansive cement and no chlorides.
3. No shrinkage when tested in conformity with ASTM C 827.

B. Performance and Design Criteria:
1. Certified to maintain initial placement volume or expand after set, and to meet following minimum properties when tested according to ASTM C 1107/C 1107M for Grades B, C, D and CRD-C621 nonshrink grout:
a. Setting Time:
1) Initial: Approximately two hours.
2) Final: Approximately three hours.
3) Comply with ASTM C 191.
b. Maximum Expansion: 0.10 to 0.40 percent.
c. Minimum Compressive Strength:
1) One-Day: 4,000 psi.
2) Seven-Day: 7,000 psi.
3) 28-Day: 10,000 to 10,800 psi.
4) Comply with CRD-C621.

2.2 FORMWORK

A. As specified in this Section and in Section 031000 - Concrete Forming and Accessories.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Requirements for installation examination.

B. Verify areas to receive grout.

3.2 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.

C. Remove defective concrete, ice, laitance, dirt, oil, grease, form release agents, paints and other foreign material from concrete surfaces, which may affect the bond or performance of the grout by brushing, hammering, chipping, sand blasting or other similar dry mechanical means until

sound and clean concrete surface is achieved. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

D. Roughen concrete lightly, but not to interfere with placement of grout.

E. Remove foreign materials from metal surfaces in contact with grout.

F. Align, level, and maintain final positioning of components to be grouted.

G. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of nonshrink cementitious grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface or other method acceptable to the Engineer. Upon completion of the 24-hour period, remove visible water from the surface prior to grouting.

H. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. Prevent bond of shims, wedges and blocking devices by bond breaking coatings and remove after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges, and blocks.

3.3 INSTALLATION - GENERAL

A. Formwork:
1. Construct leakproof forms anchored and shored to withstand grout pressures.
2. Install formwork with clearances to permit proper placement of grout.
3. As specified in Section 031000 - Concrete Forming and Accessories.

B. Placing of Grout:
1. Place grout material quickly and continuously.
2. Do not use pneumatic-pressure or dry-packing methods.
3. Apply grout from one side only to avoid entrapping air.
4. Do not vibrate placed grout mixture or permit placement if area is being vibrated by nearby equipment.
5. Thoroughly compact final installation and eliminate air pockets.
6. Do not remove leveling shims for at least 48 hours after grout has been placed.

C. Curing:
1. Prevent rapid loss of water from grout during first 48 hours by using wet burlap bags, soaker hoses or ponding.
2. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. After grout has attained its initial set, keep damp for minimum three days.

D. Reflect all existing underlying partial contraction joints, and construction joints through the grout.

3.4 SCHEDULE

A. Use particular types of grout as follows:
   1. General Purpose Nonshrink Cementitious Grout (CRD-C621 Grade D): Use at locations where nonshrink grout is indicated, except for base plates greater in area than 3-feet wide by 3-feet long.

END OF SECTION 036000

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SECTION 042000 - UNIT 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. Stone trim units.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry-joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.
10. Masonry-cell fill.

B. Products Installed but not Furnished under this Section:
1. Cast-stone trim in unit masonry.
2. Steel lintels in unit masonry.

C. Related Requirements:
1. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
2. Section 071900 "Water Repellents" for water repellents applied to unit masonry assemblies.
3. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

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

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:
1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.

2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.

C. Samples for Initial Selection:
1. Clay face brick, in the form of straps of five or more bricks.
2. Colored mortar.

D. Samples for Verification: For each type and color of the following:
1. Clay face brick, in the form of straps of five or more bricks.
2. Special brick shapes.
3. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Engineer and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:
1. Masonry units.
a. Include data on material properties material test reports substantiating compliance with requirements.
b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include test report for efflorescence according to ASTM C67.
d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing according to ASTM C67.
e. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
2. Integral water repellent used in CMUs.
3. Cementitious materials. Include name of manufacturer, brand name, and type.
4. Mortar admixtures.
5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
6. Grout mixes. Include description of type and proportions of ingredients.
7. Reinforcing bars.
8. Joint reinforcement.
9. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.

2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.

E. 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 TMS 602/ACI 530.1/ASCE 6.

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

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockups for typical exterior wall in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.
   a. Include a sealant-filled joint at least 16 inches long in each mockup.
   b. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
4. Protect accepted mockups from the elements with weather-resistant membrane.
5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
   a. Approval of mockups is also for other material and construction qualities specifically approved by Engineer in writing.
   b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
6. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 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. Store preblended, dry mortar mix in delivery containers on elevated platforms 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.

1.8 FIELD 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.
   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 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 TMS 602/ACI 530.1/ASCE 6.
   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 seven days after completing cleaning.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.
   2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.3 UNIT MASONRY, GENERAL

A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.

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

C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.
   1. Where fire-resistance-rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.4 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 for outside corners unless otherwise indicated.

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units .
   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 5514/E514M 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1) ACM Chemistries.
   2) BASF Corporation.
   3) Euclid Chemical Company (The); an RPM company.
   4) GCP Applied Technologies Inc.
   5) Moxie International.

C. CMUs: ASTM C90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2000 psi.
2. Density Classification: Normal weight.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Engineer's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

2.5 MASONRY LINTELS

A. General: Provide one of the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 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.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

B. Clay Face Brick: Facing brick complying with ASTM C216 .
1. Grade: SW.
2. Type: Match existing brick of original plant..
3. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 4950 psi (34.13 MPa) .

4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67.
5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
6. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing according to ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet (3 m) or shall have a history of successful use in Project's area.
7. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
8. Where shown to "match existing," provide face brick matching color range, texture, and size of existing adjacent brickwork.
    a. Match yellow brick from original 1950's building.

2.7 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150/C 150M, 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.
1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.

B. Hydrated Lime: ASTM C207, Type S.

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

D. Masonry Cement: ASTM C91/C91M.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cemex S.A.B. de C.V.
    b. Essroc.
    c. Holcim (US) Inc.
    d. Lafarge North America Inc.
    e. Lehigh Hanson; HeidelbergCement Group.

E. Mortar Cement: ASTM C1329/C1329M.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Lafarge North America Inc.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Davis Colors.
    b. Solomon Colors, Inc.

G. Colored Cement Products: Packaged blend made from portland cement and hydrated lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Holcim (US) Inc.
        2) Lafarge North America Inc.
2. Colored Masonry Cement:
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Cemex S.A.B. de C.V.
        2) Holcim (US) Inc.
        3) Lafarge North America Inc.
3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
4. Pigments shall not exceed 10 percent of portland cement by weight.
5. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

H. Aggregate for Mortar: ASTM C144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C404.

J. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for glazed or pre-faced masonry units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's colors.

K. Refractory Mortar Mix: Ground fireclay or nonwater-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.

L. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. BASF Corporation.
    b. Euclid Chemical Company (The); an RPM company.
    c. GCP Applied Technologies Inc.

M. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. ACM Chemistries.
    b. BASF Corporation.

c. Euclid Chemical Company (The); an RPM company.
d. GCP Applied Technologies Inc.

N. Water: Potable.

2.8 REINFORCEMENT

A. Comply with Section 032000 “Concrete Reinforcing.”

B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to 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.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dur-O-Wal; a Hohmann & Barnard company.
b. Heckmann Building Products, Inc.
c. Hohmann & Barnard, Inc.

C. Masonry-Joint Reinforcement, General: ASTM A951/A951M.
1. Interior Walls: Hot-dip galvanized carbon steel.
2. Exterior Walls: Stainless steel.
3. Wire Size for Side Rods: 0.187-inch diameter.
4. Wire Size for Cross Rods: 0.187-inch diameter.
5. Wire Size for Veneer Ties: 0.187-inchdiameter.
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.

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

E. Masonry-Joint Reinforcement for Multiwythe Masonry:
1. Ladder type with one side rod at each face shell of hollow masonry units more than 4 inches wide, plus two side rods at each wythe of masonry 4 inches wide or less.
2. Tab type, either ladder or truss design, with one side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8-inchcover on outside face.
3. Adjustable (two-piece) type, either ladder or truss 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 horizontal play of 1/16 inch and maximum vertical 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.

2.9 TIES AND ANCHORS

A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.

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

1. Retain first option in "Stainless-Steel Wire" Subparagraph below unless higher corrosion resistance of Type 316 is required.
2. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
2. Where wythes are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch-diameter, stainless-steel wire.

D. 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-diameter, stainless-steel wire.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, stainless-steel wire.

E. 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; formed from 0.062-inch-thick, stainless-steel sheet.
2. Tie Section: Triangular-shaped wire tie made from 0.187-inch-diameter, stainless-steel wire.

F. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.109-inch-thick, stainless-steel sheet.
3. Fabricate wire ties from 0.187-inch-diameter, stainless-steel wire unless otherwise indicated.

2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual and as follows:

B. Flexible Flashing: Use the following unless otherwise indicated:
1. Copper-Laminated Flashing: 7-oz./sq. ft. (2-kg/sq. m) copper sheet bonded between two layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1) Advanced Building Products Inc.
2) Hohmann & Barnard, Inc.
3) Wire-Bond.
4) York Manufacturing, Inc.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene .

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, 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 felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

D. Weep/Cavity 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 less than depth of outer wythe, in color selected from manufacturer's standard.

E. 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:
   2. Advanced Building Products Inc.
      a. CavClear/Archovations, Inc.
      b. Heckmann Building Products, Inc.
      c. Hohmann & Barnard, Inc.
      d. Mortar Net Solutions.
   3. Configuration: Provide one of the following:
      a. Strips, not less than 1-1/2 inches thick and 10 inches high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.

2.12 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 without discoloring or damaging masonry 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, provide products by one of the following:
      a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
      b. EaCo Chem, Inc.
      c. PROSOCO, Inc.

2.13 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 mortar.
4. For reinforced masonry, use portland cement-lime mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

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 C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type N.
3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
3. Mix to match Engineer's sample.
4. Application: Use pigmented mortar for exposed mortar joints with the following units:
   a. Clay face brick.
   b. Cast-stone trim units.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
1. Mix to match Engineer's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints with the following units:
   a. Clay face brick.
   b. Cast-stone trim units.

F. 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 TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

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 the Work.
   2. Verify that foundations are within tolerances specified.
   3. Verify that reinforcing dowels are properly placed.
   4. Verify that substrates are free of substances that impair mortar bond.

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 construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

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

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

D. 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.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C67. 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 inchtotal.

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.
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 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 pattern to match existing original plant; 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 4 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 stepping 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.

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 nonload-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 nonload-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.
   4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:
   1. Bed face shells in mortar and make head joints of depth equal to bed joints.
   2. Bed webs in mortar in all courses of piers, columns, and pilasters.
   3. Bed webs in mortar in grouted masonry, including starting course on footings.
   4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
   5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

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.
   4. Rake out mortar joints for pointing with sealant.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
   1. For glazed masonry units, use a nonmetallic jointer 3/4 inch or more in width.

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

F. Cut joints flush where indicated to receive cavity wall insulation unless otherwise indicated.

3.6 COMPOSITE MASONRY

1. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
   a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
   b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
2. Header Bonding: Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not more than 8 inches clear horizontally and 16 inches clear vertically.

B. Bond wythes of composite masonry together using bonding system indicated on Drawings.

C. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.

D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
   1. Provide continuity with masonry-joint reinforcement at corners by using prefabricated L-shaped units as well as masonry bonding.

E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
   1. Provide continuity with masonry-joint reinforcement by using prefabricated T-shaped units.
   2. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.7 CAVITY WALLS

A. Bond wythes of cavity walls together as follows:
   1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 24 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-type (two-piece-type) ties.
      b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.
   2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.

a. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement to allow for differential movement regardless of whether bed joints align.

B. Bond wythes of cavity walls together using bonding system indicated on Drawings.

C. 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.

D. Parge cavity face of backup wythe in a single coat approximately 3/8 inch thick. Trowel face of parge coat smooth.

E. 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.

3.8 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.

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.

3.9 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. Anchor masonry with anchors embedded in masonry joints and attached to structure.
2. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.10 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 as follows:
   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.

C. Form expansion joints in brick as follows:
   1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
   2. Build flanges of factory-fabricated, expansion-joint units into masonry.
   3. Build in compressible joint fillers where indicated.
   4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
   1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 LINTELS

A. Install steel lintels where indicated.

B. 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.

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

3.12 FLASHING, WEEP HOLES, AND CAVITY VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install cavity vents at shelf angles, ledges, 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 multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and through inner wythe to within 1/2 inchof the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches, and 1-1/2 inches into the inner wythe. Form 1/4-inch hook in edge of flashing embedded in inner wythe.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry 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.
5. 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 079200 "Joint Sealants" for application indicated.
6. 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 Section 079200 "Joint Sealants" for application indicated.
7. 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.
8. Install metal flashing termination 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 flashing termination.
9. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
1. Use specified weep/cavity vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches o.c. unless otherwise indicated.

F. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

G. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
   1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.13 REINFORCED UNIT MASONRY

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 that of other loads that may be placed on them during construction.

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

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 TMS 602/ACI 530.1/ASCE 6 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.

3.14 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 Engineer'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 applicable cleaning methods indicated in NCMA TEK 8-4A.
7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
8. Clean stone trim to comply with stone supplier's written instructions.
9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.15 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.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches in each dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earthwork."
   3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

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SECTION 047200 - CAST STONE 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. Cast-stone trim including the following:
      a. Window sills.
      b. Wall caps.
      c. Belt courses.
      d. Plaque sign with inset date

B. Related Sections:
   1. Section 042000 "Unit Masonry" for installing cast-stone units in unit masonry.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. or cast-stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Show fabrication and installation details for cast-stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
   1. Include building elevations showing layout of units and locations of joints and anchors.

C. Samples for Initial Selection: For colored mortar.

D. Samples for Verification:
   1. For each color and texture of cast stone required, 10 inches square in size.
   2. For each trim shape required, 10 inches in length.
   3. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.
   1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C1364.

B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364, including test for resistance to freezing and thawing.
   1. Provide test reports based on testing within previous two years.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer of cast-stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute the Architectural Precast Association or the Precast/Prestressed Concrete Institute for Group A, Category AT.

B. Testing Agency Qualifications: Qualified according to ASTM E329E 329 for testing indicated.

C. Mockups: Furnish cast stone for installation in mockups specified in Section 042000 "Unit Masonry."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work and to minimize the need for on-site storage.

B. Pack, handle, and ship cast-stone units in suitable packs or pallets.
   1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast-stone units if required, using dollies with wood supports.
   2. Store cast-stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

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

D. Store mortar aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

1.7 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Cast Stone: Obtain cast-stone units from single source from single manufacturer.

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

2.2 CAST-STONE MATERIALS

A. General: Comply with ASTM C1364.

B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast-stone color indicated.

C. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast-stone textures and colors.

D. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

E. Admixtures: Use only admixtures specified or approved in writing by Engineer.
   1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
   2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
   3. Air-Entraining Admixture: ASTM C260/C260M. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
   4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
   6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.

F. Reinforcement: Deformed steel bars complying with ASTM A615/A615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast-stone material.
   1. Epoxy Coating: ASTM A775/A775M.
   2. Galvanized Coating: ASTM A767/A676M.

G. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666, Type 304.

2.3 CAST-STONE UNITS

A. Cast-Stone Units: Comply with ASTM C1364.
   1. Units shall be manufactured using the vibrant dry tamp method.
   2. Units shall be resistant to freezing and thawing as determined by laboratory testing according to ASTM C 666/C 666M, Procedure A, as modified by ASTM C1364.

B. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
   1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
   2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
   3. Provide drips on projecting elements unless otherwise indicated.

C. Fabrication Tolerances:
   1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
   2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
   3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
   4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

D. Cure Units as Follows:
   1. Cure units in enclosed, moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
   2. Keep units damp and continue curing to comply with one of the following:
      a. No fewer than five days at mean daily temperature of 70 deg F or above.
      b. No fewer than six days at mean daily temperature of 60 deg F or above.
      c. No fewer than seven days at mean daily temperature of 50 deg F or above.
      d. No fewer than eight days at mean daily temperature of 45 deg F or above.

E. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

F. Colors and Textures: Provide units with fine-grained texture and buff color resembling smooth-finished Indiana limestone.

G. Colors and Textures: Provide units with fine texture and red-brown color resembling brownstone on adjacent buildings.

2.4 MORTAR MATERIALS

A. Provide mortar materials that comply with Section 042000 "Unit Masonry."

2.5 ACCESSORIES

A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666.

B. Dowels: 1/2-inch-diameter round bars, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666.

C. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast-stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 SETTING CAST STONE IN MORTAR

A. Install cast-stone units to comply with requirements in Section 042000 "Unit Masonry."

B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
   1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
   2. Coordinate installation of cast stone with installation of flashing specified in other Sections.

C. Wet joint surfaces thoroughly before applying mortar or setting in mortar.

D. Set units in full bed of mortar with full head joints unless otherwise indicated.
   1. Set units with joints 3/8 to 1/2 inch wide unless otherwise indicated.
   2. Build anchors and ties into mortar joints as units are set.
   3. Fill dowel holes and anchor slots with mortar.
   4. Fill collar joints solid as units are set.
   5. Build concealed flashing into mortar joints as units are set.
   6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
   7. Keep joints at shelf angles open to receive sealant.

E. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.

F. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.

G. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.

H. Rake out joints for pointing with sealant to depths of not less than 3/4 inch. Scrub faces of units to remove excess mortar as joints are raked.

I. Point joints with sealant to comply with applicable requirements in Section 079200 "Joint Sealants."
   1. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

J. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.
   1. Keep joints free of mortar and other rigid materials.
   2. Build in compressible foam-plastic joint fillers where indicated.
   3. Form joint of width indicated, but not less than 3/8 inch.
   4. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
   5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

A. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
   1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
   2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast-stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.
   1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast-stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.
   1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.

G. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 079200 "Joint Sealants."

3.4 INSTALLATION TOLERANCES

A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.

D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

3.5 ADJUSTING AND CLEANING

A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Engineer.

B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.

C. In-Progress Cleaning: Clean cast stone as work progresses.
   1. Remove mortar fins and smears before tooling joints.
   2. Remove excess sealant immediately, including spills, smears, and spatter.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
   2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Engineer's approval of sample cleaning before proceeding with cleaning of cast stone.
   3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
   4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
   5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
   6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 047200

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SECTION 050519 - POST-INSTALLED ANCHORS AND REINFORCING BARS

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. Post-installed adhesive and expansion anchors for concrete and concrete masonry unit substrates.
2. Post-installed reinforcing bar dowels using adhesive anchoring system.

B. Related Requirements:

1. Section 033000 “Cast-In-Place Concrete” and related Sections for concrete, reinforcement, and accessories.
2. Section 042000 “Unit Masonry” for concrete masonry units and accessories.
3. Various Sections in Division 05 related to metals.
4. Various Sections in Divisions 21, 22, 23, and 26 related to facility utilities.
5. Various Sections in Divisions 40, 41, 43, and 46 related to process mechanical equipment.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to post-installed anchors including, but not limited to, the following:
   a. Verify specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Materials, material application, sequencing, tolerances, and required clearances.
   c. Temperature, humidity & moisture limitations for adhesive anchoring system.
   d. Manufacturer’s instructions for installation of expansion anchors and adhesive anchoring system.
   e. Quality-control program.
   f. Coordination with building occupants.
2. Attendees:
   a. Owner.
   b. Resident Engineer.
   c. Contractor.
   d. Engineer.
   e. Manufacturer Representative.

1.4 ACTION SUBMITTALS

A. Submit in accordance with Section 013300.

B. Post-Installed Expansion Anchors:

1. Design Data: Submit manufacturer's specifications and data including recommended design values and physical characteristics for expansion anchors.
2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed expansion anchors installed into cracked concrete and masonry.
3. Installation Procedures: Submit procedures stating product proposed for use, and complete installation method.

C. Post-Installed Adhesive Anchoring System:

1. Design Data: Submit manufacturer's specifications and data including recommended design values and physical characteristics, including temperature, humidity, and moisture limitations for adhesive anchoring system.
2. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, materials and finishes for post-installed adhesive anchoring system installed into cracked concrete and masonry.
3. Installation Procedures: Submit procedures stating method of drilling, product proposed for use, and complete installation method.

1.5 INFORMATIONAL SUBMITTALS

A. Installation procedure: Submit installation procedure for post-installed adhesive anchoring system; including method of drilling.

B. Qualification Data:

1. Installer: Indicate manufacturer's training date and a list of personnel trained on installation of adhesive anchoring system.

C. Evaluation Reports: From ICC-ES for expansion anchors and adhesive anchoring system, for installation of post-installed anchors into cracked concrete or concrete masonry unit, as applicable, indicating conformance with current ICC ES Acceptance Criteria.

1.6 QUALITY ASSURANCE

A. General: Coordinate with the work of other Sections, field verifying dimensions and work of other trades adjoining items of work before installing items specified in this Section.

B. Adhesive Anchoring System:

1. Installer Training: Conduct thorough training by the manufacturer or the manufacturer's representative. Training shall consist of the complete installation process for post-installed anchors and reinforcing bar dowels, including but not limited to:

a. Tool selection.
b. Hole drilling procedure.
c. Hole preparation and cleaning techniques.
d. Adhesive injection technique and dispenser training and maintenance.
e. Anchor preparation and installation.
f. Reinforcing bar dowels preparation and installation.
g. Proof loading and torqueing.
h. Temperature, humidity, and moisture limitations.
i. Working time limitations.
j. Setting time.

2. Manufacturer's Certificate of Proper Installation: Submit upon completion of work, for the post-installed anchors and reinforcing bar dowels.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Handle materials with cranes or derricks. Do not dump material off transportation vehicles or handle in ways that will cause damage.

C. Store materials elevated above grade and block up so they will not become bent or otherwise damaged.

D. Repair items that have become damage or corroded to satisfaction of the Engineer prior to incorporating them into the work.

PART 2 - PRODUCTS

2.1 EXPANSION ANCHORS

A. Fastening to Concrete Substrate: Zinc plated carbon steel wedge type anchors, complete with zinc plated nuts and washers, unless otherwise noted.

B. Submerged or Weather Exposed Substrates: ASTM A276 Type 316 stainless steel wedge type anchors, complete with Type 316 stainless steel nuts and washers, unless otherwise noted.

C. Meet ICC ES AC01 or ICC ES AC193.

D. Length: When length or anchor embedment is not indicated, provide length sufficient to place the wedge and expansion cone portion of the anchor at least 1 inch behind concrete reinforcing steel.

E. Basis-of-Design:

1. Anchorage designs indicated are based on Hilti, Kwik-Bolt TZ, unless otherwise noted.

2. Acceptable Anchors: Hilti Kwik-Bolt TZ; Simpson Strong-Tie Strong Bolt 2 Wedge Anchor; DeWalt Power-Stud+ SD1; DeWalt Power-Stud+ SD6 for stainless steel; or equal.

2.2 ADHESIVE ANCHORING SYSTEM

A. Fastening to Concrete Substrate: Manufactured system consisting of post installed threaded rods, nuts, washers, other anchoring hardware, and chemical dispenser for installation in hammer drilled holes.

1. Anchors: Meet ICC ES AC308.
2. Injection Adhesive: Two-component epoxy system consisting of a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep both components separate.

    a. Adhesive: Made for use in contact with potable water.

3. Adhesive Cartridge: Side-by-side design to accept a static mixing nozzle which thoroughly blends both components and allows injection directly into a drilled hole.
4. Anchor: Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.

    a. Basis-of-Design:

        1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
        2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

5. Reinforcing Bar Dowels: Reinforcing bar, per Section 032000.

    a. Basis-of-Design:

        1) Anchorage designs indicated are based on Hilti HIT- RE 500 V3, unless otherwise noted.
        2) Acceptable Manufacturers: Hilti HIT- RE 500 V3; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal.

B. Fastening to Hollow Concrete Block, or Hollow-Core Precast Concrete Planks: Three-part threaded rod, screen tube, and chemical dispenser anchoring system.

1. Anchors: Meet ICC ES AC58.
2. Adhesive Cartridges: Contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser.
3. Anchor: or Type 316 stainless steel as indicated consisting of an all-thread anchor rod with nut and washer, of matching material to anchor rod.
4. Reinforcing Bar Dowel: Reinforcing bar, per Section 032000.
5. Basis-of-Design:

    a. Anchorage designs indicated are based on Hilti HIT HY-70 System, unless otherwise noted; or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install anchoring system in strict compliance with manufacturer's published installation instructions and approved Shop Drawings. Comply with recommended surface preparation, temperature, and moisture of substrate and ambient conditions.
2. Coordinate installation with Special Inspector.
3. Use drill bit of correct diameter and drill to required depth using rotary impact type hammer drills with carbide-tipped bits.
4. Drill holes perpendicular to concrete surface, unless otherwise indicated.
5. Use oil free compressed air to blast out loose particles and dust from drilled holes.

B. Expansion anchors:

1. Check expansion anchors for tightness a minimum of 24 hours after initial installation.

C. Adhesive anchoring system:

1. Perform installation only by personnel trained in anchor installation and having certification required in PART 1 - GENERAL.
2. Inject adhesive and install anchors and reinforcing bar dowels that are clean and free of dirt, oil, grease, ice or other deleterious material which would reduce bond.

END OF SECTION 050519

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SECTION 055000 - METAL FABRICATIONS

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. Miscellaneous items fabricated from steel or aluminum.
2. Aluminum ladder and support elements for access to roof scuttle.
3. Fall Prevention Systems.
4. Other cast-in-place items as shown or required for completion of the work.
5. Shelf angles to supporting masonry and anchor bolts to attach wood blocking to masonry.
6. Loose lintels, bent plates, miscellaneous plates.
7. Other items built into masonry as shown or required for completion of the work.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 036000 “Grouting” for non-shrink grout.
3. Section 050519 “Post-Installed Anchors and Reinforcing Bars” for anchors and reinforcing bars installed into hardened concrete or masonry.
4. Various Sections in Divisions 40 - 46 for process mechanical work scopes.

1.3 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 metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

A. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous items fabricated from steel or aluminum.
2. Aluminum ladder.
3. Fall Prevention Systems.
4. Shelf angles.

B. Product Data: For the following:

1. Paint products.

C. Samples:

1. Submit samples as requested by the Engineer during construction.

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by aluminum manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

1. Certify that welders have been qualified under AWS, within previous 12 months, to perform welds required under this Section.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

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

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

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

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.

B. Steel HSS Shapes, and Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

D. Aluminum Extrusions: ASTM B 221, Alloy 6061 T6.

E. Stainless steel Bolts: ASTM F593, Type 316.

F. Stainless steel Nuts: ASTM F594, Type 316.

G. Welding electrodes, steel: AWS A5.1 E70xx.

2.2 FASTENERS

A. Unless otherwise noted, provide stainless steel machine bolts for the connection of aluminum or stainless-steel.

B. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners.

2.3 MISCELLANEOUS ALUMINUM

A. Miscellaneous Aluminum: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal threads on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Weld on unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous Aluminum Items: Beams, angles, closure angles, stair nosings, and other miscellaneous aluminum indicated and not otherwise specified.

D. Stair Treads for Aluminum Stairs: As specified for grating and having cast abrasive non-slip nosing as approved.

E. Aluminum Finishes:

1. Anodized Finish: Give an anodic oxide treatment in accordance with AAMA 611, Class I, AA M31C22A41 for the following items, all aluminum construction.

2.4 MISCELLANEOUS STEEL

A. Miscellaneous Steel Work: Formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Drill or punch holes. Smooth edges without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and Accessories: Sufficient strength to safely withstand the stresses and strains to which they will be subjected. Close fitting exposed joints and jointed where least conspicuous. Conceal thread on threaded connections where practical. Provide continuous welds or intermittent welds on welded connections as specified or shown. Dress face of welds flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous Steel Items: Beams, angles, plates, detailed on the Drawings, support brackets, and any other miscellaneous steel indicated and not otherwise specified.

D. Steel Finish Work: Thoroughly cleaned, by effective means, of loose mill scale, rust and foreign matter. Provide one shop coat of primer compatible with finish coat after fabrication but before shipment. Omit paint within 3 inches of proposed field welds. Apply paint to dry surfaces and be thoroughly and evenly spread and well worked into joints and other open spaces.

2.5 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.
2. Ladders, ladder accessories and ladder clearances shall conform to the requirements of OSHA.

B. Aluminum Ladders:

1. Space siderails minimum 18 inches apart, unless otherwise indicated.
2. Siderails: as indicated.
3. Rungs: as indicated.
4. Fit rungs in centerline of siderails; fasten as indicated.
5. Wall Support Brackets: Aluminum 6061-T6 spaced 4 feet on center with Type 316 stainless steel adhesive anchors. Fasten side rails to floor with ½-inch diameter Type 316 stainless steel expansion anchors.

2.6 LADDER SAFETY SYSTEM

A. Provide a ladder safety system as indicated.
1. Provide an aluminum or stainless steel vertical rigid rail, rail brackets for continuous travel, rail extension, stainless steel mounting hardware and fasteners, two non-corrosive

metal sliding fall prevention devices, two full body harnesses with "D" rings, accessories and other materials required for complete installation and operation of ladder safety system in accordance with manufacturer's recommendations.

2. Provide 36-inch minimum height permanent aluminum or stainless steel rail extension compatible with sliding fall prevention device to ensure worker is attached to ladder safety system while mounting and dismounting from a platform or landing. Provide removable ladder extensions at manholes, hatches, and roof scuttles. Provide stainless steel hardware and fasteners, accessories, and other materials required for complete installation to ladders in accordance with manufacturer's recommendations.
3. Provide alignment between successive pieces of rail. Provide allowance for expansion and contraction on long runs.
4. In addition to "D" ring used for attachment to sliding fall prevention device, provide harnesses with at least two "D" rings for attachment of safety straps and lanyards.
5. Attach ladder safety system to installed ladders. Provide sliding fall prevention device allowing worker to climb up and down using both hands and move freely up and down the rail with worker in normal climbing position. Do not allow connection between sliding fall prevention device and harness attachment point to exceed 9 inches. Fabricate ladder safety system to stop the fall of a worker independently from offset ladders, platforms, or safety cages.
6. Conform to OSHA Regulation 1910.21 for ladder safety system. Rope or cable systems will not be allowed.
7. Basis-of-Design - Ladder Safety System: Saf-T-Climb by Honeywell International Inc.; Railok 90 by 3M Fall Protection; GlideLoc System by Honeywell International Inc.; or equal.

2.7 LADDER ACCESSORIES

A. Provide ladder safety post extensions on fixed ladders located below roof scuttles and as indicated. Locking aluminum telescoping safety post extension in its vertical position and extend a minimum of 36-in above opening and be secured to ladder rungs with stainless steel fasteners and brackets.

1. Basis-of-Design: Ladder UP Safety Post, Model LU-4 by Bilco Co.; Series L1E Safety Extension by Halliday Products; or equal.

2.8 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099100 "Painting".

B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.9 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. 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.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with 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.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/4 by 1 inch, with a minimum 6-inch embedment and 1½-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.10 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel or aluminum shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

2.11 FINISHES, GENERAL

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL FINISHES

A. Shop prime steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099100 "Painting" unless zinc-rich primer is indicated.

B. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 03 and Division 04 respectively. Install items to be attached to concrete or masonry after such work is completed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

B. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding after welding.

C. Clean and repair, after installation, zinc coating which has been burned by welding, abraded, or otherwise damaged. Thoroughly clean damaged area and remove all traces of welding flux and loose or cracked zinc coating prior to painting. Paint the cleaned area per the requirements of ASTM A780.

D. Install specialty products in accordance with the manufacturer's recommendations.

E. Weld headed anchor studs in accordance with manufacturer's recommendations.

F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

G. 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 surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

H. Field Welding: 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.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

I. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

J. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

K. Corrosion Protection: Coat concealed surfaces of aluminum and steel that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Aluminum Contacting a Dissimilar Metal: Apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.
2. Aluminum Contacting Masonry or Concrete: Apply a heavy coat of approved alkali resistant paint to the masonry or concrete.
3. Steel Contacting Exposed Concrete or Masonry: Apply heavy bitumastic troweling mastic.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 ROOFTOP GUARDRAIL SYSTEM

A. Install rooftop guardrail system level, plumb, true to line and elevation, and without jags in alignment.

B. Install rooftop guardrail system in place so they are capable of resisting indicated loads.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099100 "Painting."

END OF SECTION 055000

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SECTION 067413 - FIBERGLASS REINFORCED PLASTIC COMPONENTS

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 FRP gratings and supporting members.

1.3 DEFINITIONS

A. FRP: Refers to fiberglass reinforced plastic or glass fiber reinforced plastics.

1.4 COORDINATION

A. Coordinate installation of anchorages for gratings, and supporting members.

B. 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 as specified in Division 03. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

A. Test Data: Certified data based on tests of actual production samples which demonstrate that products conform to specified stress and deflection requirements.

B. Shop Drawings: Include plans, sections, details, and attachments to other work.

C. Delegated-Design Submittal: For FRP components, as required by Division 00 and Division 01.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer confirming registration in Commonwealth where project site exists.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturers of fiberglass reinforced plastic components shall be experienced in the manufacture of the items specified. Present proof as required

demonstrating successful installations of the specified items under conditions similar to those of this project.

B. Coordinate the work of this Section with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

C. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Transport, lift, and handle units with care, avoiding excessive stress and preventing damage; use appropriate equipment.

B. Store in a clean dry area off the ground and protected from weather, moisture and damage; do not stack unless permitted by manufacturer.

C. Handle products to prevent damage from abrasion, cracking, chipping, twisting, deformations, and other types of damage.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design FRP components.

B. Resin for FRP components: Vinyl ester, integrally resistant without applied coatings to: ultra-violet radiation; high concentrations of hydrogen sulfide gas, its solutions and associated compounds; and to the wastewater occurring at the project site.
   1. Provide compatible and equally resistant resin as acceptable for shop and field sealing of cut edges.

C. Colors: Integral colors acceptable to the Engineer selected from standard resin colors.

D. Pultruded fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, and surfacing veil in sufficient quantities as needed by the application and/or physical properties required.

E. Minimum physical properties for pultruded structural FRP shapes and plates:
   1. Tensile Strength: According to ASTM D 638.
      a. Coupon: 30,000 psi.
      b. Full Section in Bending: 19,986 psi at 75 degrees F.

2. Modulus of Elasticity: According to ASTM D 790.
   a. 32.3 x 10^6 psi at 75 degrees F.
   b. 1.8 x 10^6 psi at 125 degrees F.
3. Barcol Hardness: 50.
4. Water Absorption: 0.75 percent (by weight), according to ASTM D 349.
5. Specific Gravity: 1.66, according to ASTM D 792.

F. Provide pultruded shapes conforming to the visual quality of ASTM D 4385.

G. Protect pultruded and molded FRP from ultraviolet (UV) degradation with:
1. Integral UV inhibitors in the resin.
2. A synthetic surfacing veil to produce a resin rich surface.

H. Structural Performance: Withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
1. Uniform load of 200 lb/sq. ft. or concentrated load of 2000 lb, whichever produces the greater stress.
2. Limit live load deflection to L/360 or 1/4 inch, whichever is less.

2.2 GRATING COMPONENTS

A. Molded FRP Gratings: Bar gratings made by placing glass-fiber strands that have been saturated with thermosetting plastic resin in molds in alternating directions to form interlocking bars without voids and with a high resin content.
1. Configuration: As required to comply with structural performance requirements.
2. Weight: maximum weight of grating panel 50 lbs.
3. Resin: Polyester.
   a. Flame-Spread Index: 25 or less when tested according to ASTM E 84.
   b. USDA Acceptance: Accepted for food-processing applications.
4. Color: Manufacturer's standard.
5. Traffic Surface: Applied abrasive finish.

B. Securely attach FRP grating to supporting members and angles using either stainless steel or FRP with stainless steel fasteners. Attach each grating panel to supporting members at a minimum of four locations, two at each edge. Provide materials and incidentals required for attaching grating to angle frame and supports under this Section.

C. Coordinate grating panel layouts with work of other Sections to provide openings for approved mechanical equipment, operators, gates, and other items which require penetrations or openings in the grating. Further subdivide grating panels and support to provide maximum panel weight of 110 lbs.

2.3 MISCELLANEOUS COMPONENTS

A. Provide structural FRP angle frames, structural support shapes, and grit impregnated plate where required and appurtenances as indicated.

B. Provide angle frames continuous around the opening in order to present an even and flat support for the grating except as otherwise indicated.

C. Provide all finished surfaces of FRP items and fabrications smooth, resin rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. Provide glass fibers well covered with resin to protect against exposure due to wear or weathering.

D. Provide all exposed surfaces smooth and true to form, consistent with ASTM D 4385.

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners.

B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 2.

C. Post-Installed Anchors: Refer to Section 050519 “Post Installed Anchors and Reinforcing Bars.”

2.5 FABRICATION

A. Shop Assembly: Shop fabricate grating sections 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.

B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form FRP components from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

D. Fit exposed connections accurately together to form hairline joints.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, and supports rigidly in place and to support indicated loads.

2.6 FRP SUPPORTING MEMBERS

A. Supporting Members for FRP Gratings: Fabricate from FRP shapes of sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
   1. Unless otherwise indicated, use shapes made from same resin as gratings.
   2. Equip units indicated to be cast into concrete or built into masonry with integral anchors.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate locations and elevations of required supports. Verify that members are properly installed to support components specified in this Section.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

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

3.2 INSTALLATION, GENERAL

A. Install assemblies in accordance with manufacturer’s installations instructions. Install products plumb, level, and square, unless otherwise required by the design.

B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

C. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing FRP components. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry. Provide additional supports at penetrations through grating in order to meet design criteria.

E. Fit exposed connections accurately together to form hairline joints.

3.3 INSTALLING FRP COMPONENTS

A. Comply with manufacturer's written instructions for installing components. Use manufacturer's standard stainless-steel anchor clips and hold-down devices for grating anchorage.

END OF SECTION 067413

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SECTION 071113 - BITUMINOUS DAMPPROOFING

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. Cold-applied, emulsified-asphalt dampproofing.

B. Related Requirements:
   1. Section 033000 "Cast-in-Place Concrete" for bituminous vapor retarders under slabs-on-grade.
   2. Section 042000 "Unit Masonry" for mortar parge coat on masonry surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 FIELD CONDITIONS

A. Weather Limitations: Proceed with application only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.

B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain primary dampproofing materials and primers from single source from single manufacturer. Provide auxiliary materials recommended in writing by manufacturer of primary materials.

2.2 PERFORMANCE REQUIREMENTS

A. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

2.3 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. BASF Corporation.
2. W.R. Meadows, Inc.

B. Trowel Coats: ASTM D 1227, Type II, Class 1.

C. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.

D. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.

2.4 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended in writing by dampproofing manufacturer for intended use and compatible with bituminous dampproofing.

B. Cut-Back-Asphalt Primer: ASTM D 41/D 41M.

C. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended in writing by manufacturer.

D. Asphalt-Coated Glass Fabric: ASTM D 1668/D 1668M, Type I.

E. Patching Compound: Epoxy or latex-modified repair mortar of type recommended in writing by dampproofing manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for surface smoothness, maximum surface moisture content, and other conditions affecting performance of the Work.

B. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for dampproofing application.

B. Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

C. Clean substrates of projections and substances detrimental to dampproofing work; fill voids, seal joints, and remove bond breakers if any.

D. Apply patching compound to patch and fill tie holes, honeycombs, reveals, and other imperfections.

3.3 APPLICATION, GENERAL

A. Comply with manufacturer's written instructions for dampproofing application, cure time between coats, and drying time before backfilling unless otherwise indicated.
   1. Apply dampproofing to provide continuous plane of protection.
   2. Apply additional coats if recommended in writing by manufacturer or to achieve a smooth surface and uninterrupted coverage.

B. Where dampproofing footings and foundation walls, apply from finished-grade line to top of footing; extend over top of footing and down a minimum of 6 inches over outside face of footing.
   1. Extend dampproofing 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
   2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where indicated as "reinforced," by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.

C. Where dampproofing exterior face of inner wythe of exterior masonry cavity walls, lap dampproofing at least 1/4 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.
   1. Extend dampproofing over outer face of structural members and concrete slabs that interrupt inner wythe.
   2. Lap dampproofing at least 1/4 inch onto shelf angles supporting veneer.

D. Where dampproofing interior face of above-grade, exterior concrete and masonry walls, continue dampproofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by dampproofing wall before constructing intersecting walls.

3.4 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

A. Concrete Foundations: Apply one fibered brush or spray coat at not less than 3 gal./100 sq. ft.

B. Concrete Backup for Brick Veneer Assemblies: Apply one brush or spray coat at not less than 1 gal./100 sq. ft.

C. Masonry Backup for Brick Veneer Assemblies: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft.

D. Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat at not less than 1 gal./100 sq. ft.

3.5 PROTECTION

A. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where panels are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

B. Correct dampproofing that does not comply with requirements; repair substrates and reapply dampproofing.

END OF SECTION 071113

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

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. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Mechanically fastened, thermoplastic polyolefin (TPO) roofing system.
3. Substrate board.
4. Roof insulation.
5. Cover board.
6. Walkways.

B. Section includes installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:
1. Section 077100 "Roof Specialties" for roof edge flashings.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.

B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
1. Layout and thickness of insulation.
2. Base flashings and membrane termination details.
3. Flashing details at penetrations.
4. Tapered insulation layout, thickness, and slopes.
5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
7. Tie-in with adjoining air barrier.

C. Samples for Verification: For the following products:
   1. Roof membrane and flashings, of color required.
   2. Walkway pads or rolls, of color required.

D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

E. Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this Section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturer.

B. Manufacturer Certificates:
   1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
      a. Submit evidence of compliance with performance requirements.
   2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

C. Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

D. Evaluation Reports: For components of roofing system, from ICC-ES.

E. Field Test Reports:
   1. Concrete internal relative humidity test reports.
   2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing system to include in maintenance manuals.

B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.

B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
   1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
   1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, and other components of roofing system.
   2. Warranty Period: 30years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Installed roofing system and flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
   1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:

D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
1. Fire/Windstorm Classification: Class 1A-90.
2. Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 SH.

E. ENERGY STAR Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

F. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A ; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

G. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

2.2 THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

A. TPO Sheet: ASTM D6878/D6878M, internally fabric- or scrim-reinforced, self-adhering TPO sheet.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products.
   c. GAF.
   d. Johns Manville; a Berkshire Hathaway company.
   e. Versico Roofing Systems.
2. Source Limitations: Obtain components for roofing system from roof membrane manufacturer.
3. Thickness: 60 mils (1.5 mm), nominal.
4. Exposed Face Color: White.

2.3 AUXILIARY ROOFING MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.

C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.

D. Roof Vents: As recommended by roof membrane manufacturer.
   1. Size: Not less than 4-inch (100-mm) diameter.

E. Bonding Adhesive: Manufacturer's standard, water based.

F. Slip Sheet: ASTM D2178/D2178M, Type IV; glass fiber; asphalt-impregnated felt.

G. Slip Sheet: Manufacturer's standard, of thickness required for application.

H. Vented Base Sheet: ASTM D4897/D4897M, Type II; nonperforated, asphalt-impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.

I. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

J. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick (25 mm wide by 1.3 mm thick), prepunched.

K. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

   1. Fasteners: 1-1/2-inch (38-mm) stainless steel fasteners with neoprene washers.

L. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.

M. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured or approved by TPO roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.

B. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.
   1. Facer: Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch (13 mm) thick.
   2. Facer: Type V, oriented strand board facer, 7/16 inch (11 mm) thick.
   3. Facer: Type VII, glass-mat-faced gypsum board facer, 1/4 inch (6 mm) thick.
   4. Size: 48 by 96 inches (1219 by 2438 mm).
   5. Thickness: 4-inch minimum.

C. Tapered Insulation: Provide factory-tapered insulation boards.
   1. Material: Match roof insulation.

2. Minimum Thickness: 1/4 inch (6.35 mm).
3. Slope:
   a. Roof Field: 1/4 inch per foot (1:48) unless otherwise indicated on Drawings.
   b. Saddles and Crickets: 1/2 inch per foot (1:24) unless otherwise indicated on Drawings.

2.5 INSULATION ACCESSORIES

A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

B. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
1. Modified asphaltic, asbestos-free, cold-applied adhesive.
2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
1. Thickness: 1/2 inch (13 mm).
2. Surface Finish: Factory primed.

2.6 ASPHALT MATERIALS

A. Roofing Asphalt: ASTM D312/D312M, Type III or Type IV.

B. Asphalt Primer: ASTM D41/D41M.

2.7 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway padsorrolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.
1. Size: Approximately 36 inches by 60 inches (914 by 1524 mm).
2. Color: Contrasting with roof membrane.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
5. Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than 75 percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.
    a. Test Frequency: One test probe per each 1000 sq. ft. (93 sq. m), or portion thereof, of roof deck, with not less than three tests probes.
    b. Submit test reports within 24 hours after performing tests.
6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
7. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
8. Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.
9. Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.
10. Verify adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch (3.2 mm) at top surface.

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

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
1. Submit test result within 24 hours after performing tests.
    a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

D. Install sound-absorbing insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 INSTALLATION OF ROOFING, GENERAL

A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

3.4 INSTALLATION OF INSULATION

A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.

B. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.

C. Installation Over Metal Decking:
   1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows.
      a. Locate end joints over crests of decking.
      b. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
      c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
      d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
      e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
         1) Trim insulation so that water flow is unrestricted.
      f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
      g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
      h. Loosely lay base layer of insulation units over substrate.
      i. Mechanically attach base layer of insulation [**and substrate board**] using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
         1) Fasten insulation according to requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI’s Directory of Roof Assemblies for specified Wind Uplift Load Capacity].
         2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

D. Installation Over Concrete Decks:
   1. Install base layer of insulation with joints staggered not less than 24 inches (610 mm) in adjacent rows.

a. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
c. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
    1) Trim insulation so that water flow is unrestricted.
e. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
f. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
g. Loosely lay base layer of insulation units over substrate.
h. Adhere base layer of insulation to concrete roof deck according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    1) Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft. (0.3 L/sq. m) and allow primer to dry.
    2) Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
    3) Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    4) Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.
    a. Staggered end joints within each layer not less than 24 inches (305 mm) in adjacent rows.
    b. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
    c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    d. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
    e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches (610 mm).
        1) Trim insulation so that water flow is unrestricted.
    f. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
    g. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
    h. Loosely lay each layer of insulation units over substrate.
    i. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
        1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.5 INSTALLATION OF COVER BOARDS

A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction.
   1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
   2. At internal roof drains, conform to slope of drain sump.
      a. Trim cover board so that water flow is unrestricted.
   3. Cut and fit cover board tight to nailers, projections, and penetrations.
   4. Loosely lay cover board over substrate.
   5. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
      a. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
      b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
      c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install slip sheet over cover board and beneath roof membrane.

3.6 INSTALLATION OF ADHERED ROOF MEMBRANE

A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.

B. Unroll roof membrane and allow to relax before installing.

C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.

D. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

F. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fabric-backed roof membrane. Do not apply to splice area of roof membrane.

G. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed roof membrane.

H. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.

I. Apply roof membrane with side laps shingled with slope of roof deck where possible.

J. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.
   1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
   2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
   3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

K. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.7 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 INSTALLATION OF WALKWAYS

A. Flexible Walkways:
   1. Install flexible walkways at the following locations:
      a. Retain one or more subparagraphs below. Revise to suit Project.
      b. Perimeter of each rooftop unit.
      c. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
      d. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
      e. Top and bottom of each roof access ladder.
      f. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

g. Locations indicated on Drawings.
h. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch (76-mm) clearance between adjoining pads.
3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.9 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Engineer and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
1. Owner: <**Insert name of Owner**>.
2. Address: <**Insert address**>.
3. Building Name/Type: <**Insert information**>.
4. Address: <**Insert address**>.
5. Area of Work: <**Insert information**>.
6. Acceptance Date: _____.
7. Warranty Period: <**Insert time**>.
8. Expiration Date: _____.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
a. lightning;
b. fire;

c. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
d. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
e. vapor condensation on bottom of roofing; and
f. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

1. Authorized Signature: _____.
2. Name: _____.
3. Title: _____.

END OF SECTION 075423

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SECTION 077100 - ROOF SPECIALTIES

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. Reglets and counterflashings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof specialties.
   1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of roof specialty.

C. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roofing specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.

B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication and indicate measurements on Shop Drawings.

B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
      a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

C. Downspouts: Plain rectangular complete with machine-crimped elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
   1. Formed Aluminum: 0.063 inch thick.

D. Parapet Scuppers: Manufactured with closure flange trim to exterior, 4-inch- wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof.
   1. Formed Aluminum: 0.032 inch thick.

E. Conductor Heads: Manufactured conductor heads, each with flanged back and stiffened top edge, and of dimensions and shape indicated, complete with outlet tube that nests into upper end of downspout, exterior flange trim, .
   1. Formed Aluminum: 0.032 inch thick.

F. Aluminum Finish: Three-coat fluoropolymer .
   1. Color: As selected by Engineer from manufacturer's full range.

2.2 REGLETS AND COUNTERFLASHINGS

A. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
   1. Stainless Steel: 0.025 inch thick.
   2. Corners: Factory mitered and mechanically clinched and sealed watertight.
   3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
   4. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.

B. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches and in lengths not exceeding 12 feet designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
   1. Stainless Steel: 0.025 inch thick.

C. Accessories:
   1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.
   2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

D. Stainless-Steel Finish: No. 4 (bright, polished directional satin).

2.3 MATERIALS

A. Aluminum Sheet: ASTM B 209, alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.

B. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
   1. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
   2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

B. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.

C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.

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

3.2 INSTALLATION, GENERAL

A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
   1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
   2. Provide uniform, neat seams with minimum exposure of solder and sealant.
   3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
   4. Torch cutting of roof specialties is not permitted.
   5. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
   1. Coat concealed side of stainless-steel roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
   2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.

C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.

1. Space movement joints at a maximum of 12 feet with no joints within 18 inches of corners or intersections unless otherwise indicated on Drawings.
2. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.

D. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.

E. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F.

F. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets to be soldered to a width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work. Tin edges of uncoated copper sheets using solder for copper. Do not use torches for soldering. Heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

3.3 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.

B. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c.
1. Provide elbows at base of downspouts at grade to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

C. Parapet Scuppers: Install scuppers through parapet where indicated. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.
1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

D. Conductor Heads: Anchor securely to wall with elevation of conductor top edge 1 inch below scupper discharge.

3.4 REGLET AND COUNTERFLASHING INSTALLATION

A. General: Coordinate installation of reglets and counterflashings with installation of base flashings.

B. Surface-Mounted Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches over top edge of base flashings.

C. Counterflashings: Insert counterflashings into reglets or other indicated receivers; ensure that counterflashings overlap 4 inches over top edge of base flashings. Lap counterflashing joints a minimum of 4 inches and bed with butyl sealant. Fit counterflashings tightly to base flashings.

3.5 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.

D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

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. Roof curbs.
   2. Roof hatches.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.
   1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

D. Delegated-Design Submittal: For roof curbs 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. Detail mounting, securing, and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.
   2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

E. Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this Section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
   1. Size and location of roof accessories specified in this Section.
   2. Method of attaching roof accessories to roof or building structure.
   3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
   4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 ROOF HATCH

A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. BILCO Company (The).

B. Type and Size: Single-leaf lid, 30 by 36 inches.

C. Loads: Minimum 40-lbf/sq. ft. external live load and 20-lbf/sq. ft. internal uplift load.

D. Hatch Material: Stainless-steel sheet.
   1. Thickness: Manufacturer's standard thickness for hatch size indicated.
   2. Finish: Manufacturer's standard.

E. Construction:
   1. Insulation: Cellulosic-fiber board.
      a. R-Value: 12.0 according to ASTM C 1363.
   2. Nailer: Factory-installed wood nailer continuous around hatch perimeter.
   3. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   4. Hatch Lid: Glazed, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
   5. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
   6. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
   7. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.

F. Hardware: Spring operators, hold-open arm, stainless-steel spring latch with turn handles, stainless-steel butt- or pintle-type hinge system, and padlock hasps inside and outside.
   1. Provide two-point latch on lids larger than 84 inches.
   2. Provide remote-control operation.

G. Safety Railing System: Roof-hatch manufacturer's standard system including rails, clamps,

H. Ladder-Assist Post: Roof-hatch manufacturer's standard device for attachment to roof-access ladder.
   1. Operation: Post locks in place on full extension; release mechanism returns post to closed position.
   2. Height: 42 inches above finished roof deck.
   3. Material: Aluminum.
   4. Post: 1-5/8-inch-diameter pipe.
   5. Finish: Manufacturer's standard baked enamel or powder coat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

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

3.2 INSTALLATION

A. General: Install roof accessories according to manufacturer's written instructions.
   1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.

2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Roof-Hatch Installation:
1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attach safety railing system to roof-hatch curb.
3. Attach ladder-assist post according to manufacturer's written instructions.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 078443 - JOINT FIRESTOPPING

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. Joints in or between fire-resistance-rated constructions.
   2. Joints in smoke barriers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
   1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm with 5 years’ experience in successfully installing fire-resistive joint firestopping systems similar to that specified. Have experience, staff, and training to install manufacturer's products per specified requirements. Being able to purchase manufacturer's products does not meet installer qualification.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.6 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. 3M Fire Protection Products.
      b. Rockwool International.
      c. Thermafiber, Inc.; an Owens Corning company.
      d. Tremco, Inc.
   2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
   1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
   2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
   1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
   1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
   2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
   3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If

damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078443

SECTION 079200 - JOINT SEALANTS

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. Urethane joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.
   3. Joint-sealant formulation.
   4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
   1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
   2. When joint substrates are wet.
   3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
   4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BASF Corporation.
      b. Pecora Corporation.
      c. Sika Corporation; Joint Sealants.
      d. Tremco Incorporated.

2.3 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
      a. Concrete.
      b. Masonry.
   3. Remove laitance and form-release agents from concrete.
   4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
      a. Metal.
      b. Glass.
      c. Porcelain enamel.
      d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   1. Do not leave gaps between ends of sealant backings.
   2. Do not stretch, twist, puncture, or tear sealant backings.
   3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
   1. Place sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081500 - FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

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 fiberglass reinforced plastic (FRP) doors and frames.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 COORDINATION

A. Coordinate anchorage installation for fiberglass reinforced plastic (FRP) doors and 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.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, core descriptions and finishes.

B. Shop Drawings: Include the following:
   1. Elevations of each door type.
   2. Details of doors, including vertical- and horizontal-edge details and materials thicknesses.
   3. Frame details for each frame type, including dimensioned profiles and material thicknesses.
   4. Locations of reinforcement and preparations for hardware.
   5. Details of each different wall opening condition.
   6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
   7. Details of anchorages, joints, field splices, and connections.
   8. Details of accessories.
   9. Details of moldings, removable stops, and glazing.

C. Samples: For fiberglass reinforced plastic (FRP) doors and frames with factory-applied color finishes.

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
   a. Provide sample which indicate gloss level.
2. Fabrication: Prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:
   a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing and louvers if applicable.
   b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing hollow metal construction and glazing if applicable.

D. Product Schedule: For fiberglass reinforced plastic (FRP) doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

E. Regulatory Approvals: Provide copy of current, valid statewide product approval for product, material or system as shown on the drawings and as specified in this Section, in accordance with Rule 9N-3. Product approval shall be for the specific manufacturer, product type, model or style, and the State Approval Number.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of fiberglass reinforced plastic (FRP) doors and frames, for tests performed by a qualified testing agency.

B. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fiberglass reinforced plastic (FRP) doors and frames in manufacturer's original unopened packaging. Mark and remove damaged materials from the project site. Where materials are covered by a referenced specification, label the package with the specification number, type, and class, as applicable. Deliver materials in sufficient quantity to allow work to proceed without interruption.

B. Storage:
1. Protect materials against moisture absorption and contamination or other damage.
2. Store all materials on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer.
3. Do not store materials in buildings under construction until concrete, mortar, and plaster work is finished and dry.
4. Do not store materials outdoors.
5. Do not store materials in contact with other materials that might cause staining, denting, or other surface damage.

C. Handling:

1. Prevent damage to corners, edges and ends of materials. Do not install damaged materials in the work. Select and operate material handling equipment to prevent damage to materials.

1.7 REGULATORY REQUIREMENTS

A. Provide products, materials and assemblies, including anchorage, proposed for the work of this Section that comply with project specific calculated design pressures and the Florida Building Code, including wind-borne debris region requirements. Provide products designed by the Manufacturer and installed by the Contractor to meet these requirements.
   1. Provide products that conform to the project design pressures in the components and cladding table on the structural drawings. Where a conflict occurs between the requirements of this Specification and the Florida Building Code, the more stringent requirement shall apply.

B. Provide documentation that the Florida Building Code compliance for the products, materials and assemblies, including anchorage specified in this Section have been incorporated into the Work. Demonstrate code compliance with the Florida Building Code, using one of the methods outlined in Chapter 9N-3 of the Florida Administrative Code, Department of Community Affairs, Florida Building Commission, Product Approval documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following :
   1. Chempruf
   2. Corrim Company
   3. Or equal.

2.2 DOORS

A. Non-Rated Openings: Provide the following:
   1. Face Sheets - Seamless fiberglass reinforced polyester plastic, 0.110-in thick.
   2. Internal Stiles and Rails - Structural fiberglass reinforced plastic with solid polymer corner reinforcement.
   3. Core - Polyurethane, 1-1/2-inches thick, U factor - 0.14 deg Btu/F x h x sq. ft.
   4. Hardware Reinforcement - Solid polymer.
   5. Intermediate Framing - Supply structural FRP as and where required for door integrity.
   6. Chemically weld entire door.
   7. Polyester gel-coat entire door following hardware machining, 15 mils plus/minus 3 mils, dry film thickness.

B. Rated Openings: As specified above except provide mineral core, fire retardant pultruded internal FRP stiles and rails and factory installed intermescent seals recessed into edges of doors, around perimeter, all as tested and approved by UL. Provide UL label permanently fixed

to hinge edge, coordinated with placement of intermescent strip. Door rating in hours shall be equal to or greater than rating required by Door Schedule.

C. Vision Panel Trim: Polymer (PVC) vision panel trim for 6 mm thick glass. Provide factory fabricated for field installation.

2.3 FRAMES

A. Non-Rated Openings: Provide the following:
   1. Match hollow metal frames configuration 5-3/4-in wide by 2-in depth with a hollow door stop.
   2. Reinforcement - Solid polymer per templates provided by the hardware supplier.

B. Rated Openings: Welded construction, 0.067-inch (14 gauge) galvanized steel as specified in and with UL label affixed for a frame rating in hours equal to or greater than rating required by Door Schedule. Provide with three minimum and 30-inches maximum on center placement, UL approved jamb anchors for building into masonry walls as they are constructed. Grout frames fully when in place. Frame - Factory gel coat on properly prepared steel, all surfaces, inside and out, except bonding surfaces of anchors. Gel coat shall be as specified for doors.

C. Rated Openings: Provide fire rated steel window frame where scheduled with UL label, two UL anchors per jamb, steel glazing beads and gel coated, all as specified above for fire rated door frames.

2.4 LOUVERS

A. Polymer (PVC) louvers similar to louver configuration in aluminum doors.

B. V-shaped configuration, sight proof.

C. Color: Match door and frame.

2.5 ANCHORS

A. Use fiberglass reinforced T-anchors, like those used in hollow metal door construction to fasten frames to new masonry.

2.6 FASTENERS

A. Stainless steel fasteners, 300 Series as approved, shall be used for frame assembly and for all other fasteners.

2.7 PERFORMANCE REQUIREMENTS

A. Air Infiltration: When tested in accordance with ASTM E283, air infiltration is not to exceed 0.06 cubic feet per minute per square foot of fixed area at a test pressure of 6.24 pounds per square foot at 50 mile per hour wind.

B. Water Penetration: When tested in accordance with ASTM E331, no water penetration is allowed, at a pressure of 8 pounds per square foot of fixed area.

C. Provisions for Thermal Movement: Design doors and frames to provide for expansion and contraction of the component parts caused by an ambient temperature range of minus 0 to 100 degrees F causing buckling, opening of joints, overstressing of fasteners, or other harmful effects.

PART 3 - EXECUTION

3.1 PREPARATION

A. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

A. FRP Frame: Set FRP door frame plumb and true, aligned, and secured with the adjacent construction-in-place, in conformance with ASTM E2112. Anchor frame as specified and in accordance with the FRP door manufacturer's requirements.
   1. Installation Tolerances:
      a. Squareness: Plus or minus 1/16-inch, measure at the door rabbet on a line 90 degrees from the jamb perpendicular to the frame head.
      b. Alignment: Plus or minus 1/16-inch, measure at the jamb on a horizontal line parallel to the wall plane.
      c. Twist: Plus or minus 1/16-inch, measure at the opposite face corners of the jambs on parallel lines, and perpendicular to the wall plane.
      d. Plumb and True: Plus or minus 1/16-inch, measure at the jambs to the floor.

B. FRP Door: Fit and hang door in accordance with clearances specified below:
   1. Clearance Tolerances:
      a. Jambs and Head: Plus 1/8-inch or minus 1/16-inch.
      b. Pairs of Doors: Plus 1/8 inch or minus 1/16-inch.
      c. Bottom of Door and Top of Threshold: Maximum 3/8-inch.
      d. Bottom of Door and Top of finish floor (No Threshold: Maximum 3/4-inch.

C. Labeled Door and Frame: Install fire-rated door and frame, including hardware, in accordance with NFPA 101 NFPA 80 and NFPA 105.

END OF SECTION 081500

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SECTION 087100 - DOOR HARDWARE

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. Cylinders for door hardware specified in other Sections.
   2. Electrified door hardware.

B. Related Requirements:
   1. Section 081113 "Hollow Metal Doors and Frames" for astragals provided as part of labeled fire-rated assemblies and for door silencers provided as part of hollow-metal frames.
   2. Section 281300 "Access Control" for access control devices installed at door openings and provided as part of a security system.

1.3 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.
   1. Include diagrams for power, signal, and control wiring.
   2. Include details of interface of electrified door hardware and building safety and security systems.

C. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
   1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
   2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
   3. Content: Include the following information:
      a. Identification number, location, hand, fire rating, size, and material of each door and frame.
      b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
      c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
      d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
      e. Fastenings and other installation information.
      f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
      g. Mounting locations for door hardware.
      h. List of related door devices specified in other Sections for each door and frame.

D. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final door hardware schedule.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of doors and door hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
   2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
      a. Exit Devices: Two years from date of Substantial Completion.
      b. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.
   1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

2.3 SCHEDULED DOOR HARDWARE

A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.
   1. Door hardware is scheduled in Part 3 .

2.4 CONTINUOUS HINGES

A. Continuous Hinges: BHMA A156.26; minimum 0.120-inch-thick, hinge leaves with minimum overall width of 4 inches; fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.

B. Continuous, Gear-Type Hinges: Extruded-aluminum, pinless, geared hinge leaves joined by a continuous extruded-aluminum channel cap; with concealed, self-lubricating thrust bearings.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Hager Companies.
      b. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
   1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
   2. Deadbolts: Minimum 1.25-inch bolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:
   1. Description: Manufacture’s standard.
   2. Levers: Cast.
   3. Escutcheons (Roses): Cast.
   4. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.
   1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
   2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
   4. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

F. Mortise Locks: BHMA A156.13; Security Grade 1 ; stamped steel case with steel or brass parts; Series 1000.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
      b. DORMA USA, Inc.
      c. Hager Companies.
      d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.6 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic and Self-Latching Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge. Include wear plates.
   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. Cal-Royal Products, Inc.
      b. Don-Jo Mfg., Inc.
      c. Door Controls International, Inc.
      d. Trimco.

2.7 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
      b. DORMA USA, Inc.
      c. Hager Companies.
      d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.8 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

B. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.9 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.
   1. Existing System:
      a. Master key or grand master key locks to Owner's existing system.
   2. Keyed Alike: Key all cylinders to same change key.

B. Keys: Brass.
   1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
      a. Notation: "DO NOT DUPLICATE."

2.10 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: BHMA A156.22.

2.11 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. DORMA USA, Inc.
      b. Hager Companies.
      c. SARGENT Manufacturing Company; ASSA ABLOY.
      d. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.12 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pemko Manufacturing Co.
      b. Zero International, Inc.

B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:
   1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
   2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
   3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

2.13 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hager Companies.
      b. Reese Enterprises, Inc.
      c. Zero International, Inc.

2.14 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hager Companies.
   b. Rockwood Manufacturing Company; an ASSA ABLOY Group company.

2.15 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Engineer.
   1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.
   1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
   2. Fire-Rated Applications:
      a. Wood or Machine Screws: For the following:
         1) Hinges mortised to doors or frames.
         2) Strike plates to frames.
         3) Closers to doors and frames.
      b. Steel Through Bolts: For the following unless door blocking is provided:
         1) Surface hinges to doors.
         2) Closers to doors and frames.
         3) Surface-mounted exit devices.
   3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
   4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.16 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations

in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
   1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.
   1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
   2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset

pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.
   1. Replace construction cores with permanent cores as directed by Owner.
   2. Furnish permanent cores to Owner for installation.

F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

G. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

H. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
   1. Do not notch perimeter gasketing to install other surface-applied hardware.

I. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

J. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
   1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
   2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
   3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SCHEDULE

A. Hardware #1

Continuous Hinge – 2

Closer with Hold-open-2

Exit device (vertical bars top and bottom) – 2

Threshold -1

Kick-plates – 2

Astragral – 1

Weather seals

B. Hardware #2

Continuous Hinge – 1

Closer with Hold-open -1

Exit device – 1

Threshold -1

Kick plates - 1

Weather seals

END OF SECTION 087100

SECTION 088000 - GLAZING

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. Glass for windows doors.
   2. Glazing sealants and accessories.

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of the following products; 12 inches square.
   1. Insulating glass.

C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer manufacturers of insulating-glass units with sputter-coated, low-E coatings glass testing agency and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For tinted glass coated glass insulating glass andglazing sealants, for tests performed by a qualified testing agency.
   1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.

B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
   1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
   1. Warranty Period: 10 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Oldcastle BuildingEnvelope™.
   2. Viracon, Inc.
   3. Vitro Architectural Glass.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
   1. Obtain tinted glass from single source from single manufacturer.
   2. Obtain reflective-coated glass from single source from single manufacturer.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to

remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
1. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
   1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
   2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   3. Interlayer Color: Clear unless otherwise indicated.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
   2. Perimeter Spacer: Manufacturer's standard spacer material and construction .
   3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.7 GLAZING SEALANTS

A. General:
   1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
   2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
   3. Colors of Exposed Glazing Sealants: As selected by Engineer from manufacturer's full range.

B. Glazing Sealant:
   1. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Pecora Corporation.
         2) Sika Corporation.
         3) Tremco Incorporated.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
   1. AAMA 804.3 tape, where indicated.
   2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
   3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
   1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
   2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:
   1. EPDM with a Shore A durometer hardness of 85, plus or minus 5.
   2. Type recommended by sealant or glass manufacturer.

D. Spacers:
   1. Neoprene blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
   2. Type recommended by sealant or glass manufacturer.

E. Edge Blocks:
   1. EPDM with a Shore A durometer hardness per manufacturer's written instructions.
   2. Type recommended by sealant or glass manufacturer..

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product

manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
    a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry

surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 INSULATING GLASS SCHEDULE

A. Glass Type : Low-E-coated, tinted, insulating laminated glass.
1. Basis-of-Design Product:.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Outdoor Lite: 6 mm.
4. Outdoor Lite: Tinted fully tempered float glass.
5. Tint Color: Gray.
6. Interspace Content: Air.
7. Indoor Lite: Clear laminated glass with two plies of fully tempered float glass.
    a. Minimum Thickness of Each Glass Ply: 3 mm.
    b. Interlayer Thickness: 0.030 inch.
8. Low-E Coating: Pyrolytic on second surface.
9. Safety glazing required.

END OF SECTION 088000

SECTION 096723 - RESINOUS FLOORING

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. Resinous flooring systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Initial Selection: For each type of exposed finish required.

C. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project.

1.4 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Material Test Reports: For each resinous flooring system, by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Apply full-thickness mockups on 96-inch-square floor area selected by Engineer.
      a. Include 96-inch length of integral cove base with inside and outside corner.
   2. Simulate finished lighting conditions for Engineer's review of mockups.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing according to ASTM D635.

2.2 MANUFACTURERS

A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.3 RESINOUS FLOORING

A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
      a. DUDICK Inc.
      b. ROCK-TRED Corporation.
      c. Stonhard, Inc.
      d. Tnemec Inc.

B. System Characteristics:
   1. Color and Pattern: As selected by Engineer from manufacturer's full range.
   2. Wearing Surface: Textured for slip resistance.
   3. Overall System Thickness: 1/8 inch.

C. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
   1. Formulation Description: High solids.

D. Waterproofing Membrane: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.
   1. Formulation Description: High solids.

E. Reinforcing Membrane: Flexible resin formulation that is recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated and that inhibits substrate cracks from reflecting through resinous flooring.
   1. Formulation Description: High solids.
      a. Provide fiberglass scrim embedded in reinforcing membrane.

F. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

G. Body Coats:
   1. Resin: Epoxy.
   2. Formulation Description: High solids.
   3. Type: Pigmented.
   4. Application Method: Trowel with broadcast aggregates.
   5. Number of Coats: Two.
   6. Thickness of Coats: 1/8 inch.
   7. Aggregates: Manufacturer's standard.

H. Topcoats: Sealing or finish coats.
   1. Resin: Epoxy.
   2. Formulation Description: High solids.
   3. Type: Clear.
   4. Number of Coats: One.
   5. Thickness of Coats: 8 mils.
   6. Finish: Matte.

I. System Chemical Resistance: Test specimens of cured resinous flooring system are unaffected when tested according to ASTM D1308 for 50 percent immersion ASTM D543, Procedure A, for immersion ASTM C267 for immersion in the following reagents for no fewer than seven days:

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
   1. Roughen concrete substrates as follows:
      a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
      b. Comply with NACE No. 6/SSPC-SP13, with a Concrete Surface Profile (CSP) of 3 or greater in accordance with the International Concrete Repair Institute (ICRI) Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent.
   2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
   3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
      a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with application of resinous flooring only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. of slab area in 24 hours.
      b. Relative Humidity Test: Use in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75percent relative humidity level measurement.
   4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
   1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.

D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 INSTALLATION

A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
   1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
   2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
   3. Expansion and Isolation Joint Treatment: At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions.

B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.

C. Troweled or Screeded Body Coats: Apply troweled or screeded body coats in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When body coats are cured, remove trowel marks and roughness using method recommended by manufacturer.

D. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

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SECTION 099010 - SHOP PRIMING

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 shop primers not included in other sections.

B. Related Requirements:
   1. Division 09 for field applied painting.
   2. Other specifications that reference this specification for primers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include written statement, or published product data, that the confirms that the shop primer materials are compatible with the finish and field coatings.

B. Samples: For each exposed product.

1.4 QUALITY ASSURANCE

A. Compatibility of Coating Systems - Shop priming with primers that are guaranteed, in writing, by the manufacturer to be compatible with field applied and other coatings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water being treated, either submerged or which are subject to splash action or which are specified to be considered submerged service:
   1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer):
      a. TNEMEC: Series 1 Omnithane.
      b. Carboline: Carboguard 561.
      c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
      d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amerlock 400.
      e. Or equal.

B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water being treated, not submerged and not subject to splash action:
   1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer):
      a. TNEMEC: Series 1 Omnithane.
      b. Carboline: Carboguard 561.
      c. Sherwin-Williams Company (The): Corothane I Zinc Primer 1K Mio-Zinc.
      d. PPG PMC Durathane MCZ 97-679 Series or PPG PMC Amercoat 68HS.
      e. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface preparation: Comply with the manufacturer's written requirements for the substrate to be primed.

3.2 PROTECTION

A. Non-Primed Surfaces – Apply a heavy shop coat of grease or other suitable rust-resistant coating to gears, bearings surfaces and other similar surfaces which are not to be field painted.

   1. Maintain this coating to prevent corrosion until final acceptance testing of equipment.

END OF SECTION 099010

SECTION 099100 – PAINTING

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 surface preparation and the application of paint systems on the following substrates:
   1. Concrete.
   2. Concrete masonry units (CMUs).
   3. Steel and iron.
   4. Galvanized metal.
   5. Aluminum (not anodized or otherwise coated).
   6. Copper.
   7. Stainless steel.
   8. Wood.
   9. Fiberglass.
   10. Plastic.

B. Section includes painting all exposed structural and miscellaneous steel; chemical tanks and systems; mechanical and electrical equipment; sluice gates, operators and posts; conveying systems, pipe, fittings and valves; electrical conduit and appurtenances; new CMU walls; exposed interior ducts; all as specified in the attached painting schedules and all other work obviously required to be painted unless otherwise specified. Minor items not mentioned in the schedule of work shall be included in the work of this Section where they come within the general intent of this Section as stated herein.

C. Aluminized steel, above roof level, for stacks: Paint with silicone aluminum as specified. Other aluminum-paint only where noted (as is specified).

D. Paint items noted in “Painting Schedule.”

E. Provide vinyl film letters and numbers for markings as specified.

F. Paint items noted in other Specification Sections as having factory finish and other factory finished items are obviously not field painted.

G. Paint all factory finish painted items replaced, repaired or damaged during construction.

H. The various Sections are responsible, as stated in each, for preparation and field touch-up of abrasions, welds and damaged primed areas of primed or galvanized components after erection.

I. The following items will not be painted:

1. Concrete except where specified above and scheduled to be painted and seamless flooring.
2. Stainless steel louvers, doors and frames.
3. Finish hardware.
4. Non-ferrous metals and stainless steel, unless specifically noted otherwise.
5. Factory pre-finished architectural components.
6. Packing glands and other adjustable parts and name plates of mechanical equipment.
7. Parts of buildings not exposed to sight, unless specifically noted otherwise.
8. Maintenance equipment
9. Plumbing fixtures.
10. Mechanical, HVAC, Plumbing and Electrical equipment which has been finished painted in the factory as specified in Divisions 22, 23, 26, 41, 42, 43, 44, 46 and 48.

J. Related Requirements:
1. Valve identification is included in Divisions 11, 22, 23, 41, 42, 43, 44, 46 and 48.
2. Shop priming of equipment and piping (except copper piping) are specified in Section 099110 – Shop Priming and included in the respective Section with the item to be primed.
3. Section 051200 "Structural Steel Framing" for shop priming of metal substrates.
4. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 QUALITY ASSURANCE

A. Shop Primers, specified in Section 099100 “Shop Primers,” and other Sections are required to be certified by the manufacturer of the field applied painting manufacturer to be compatible with the materials specified in this section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products by one of the following:
1. Tnemec, Inc. (TN);
2. The Sherwin Williams Company (SW)
3. PPG Architectural Finishes, Inc. (PPG)
4. PPG Architectural Finishes, Inc. Ameron (AME)
5. Or equal.

2.2 MATERIALS

A. Material Compatibility:
1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.

B. Use paint materials without adulteration and mixed, thinned and applied in strict accordance with manufacturer's directions for the applicable materials and surface.

C. Colors: As selected by Engineer from manufacturer's full range .

2.3 COLOR CODING FOR PIPES AND EQUIPMENT

A. The color code establishes, defines and assigns a definite color for each process system. Paint all elements which are an integral part of the system that is originating from the equipment and/or supplying the equipment, between and up to but not including the fixed flanges nor the flexible conduit connections on the equipment. Paint valves and fittings in the color of the main body of the pipe.

B. All pipes and equipment shall be painted with final coat color selected by the Engineer and shall be treated as an integral part of the Contract.

C. All hanger saddles and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. Hanger rods and hanger rod connections to building structure shall be painted to match the color of the wall or ceiling to which it is attached.

2.4 LETTERING OF TITLES

A. Indicate the name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of fluids on each pipe system. Locate the titles shall not more than 26 feet apart and directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout and all pieces of equipment.

B. Identify titles by the identity of the contents with complete name at least once in each space through which it passes and thereafter by generally recognized abbreviations, letters or numerals as approved. Place identification title locations in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title to be clearly visible from operating positions and adjacent to all control valves.

C. Die cut numbers and letters from 3.5 mil vinyl film and pre-space them on carrier tape. Protect adhesive and finish surface with one-piece removable liners. Use white or black to provide high contrast to the substrate color.

D. Letter size shall be as indicated in the following table:

OUTSIDE DIAMETER OF PIPE OR COVERING	SIZE OF LEGEND LETTERS
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

E. Use Type B ASI/2 by ASI Sign Systems; Architectural Graphics Inc. or equal. Provide Optima Bold, upper case letter type. Use Grid 2 spacing. Match arrow to letter type and size. Follow the instructions of the manufacturer in respect to storage, surface preparation and applications of letters.

2.5 TITLES FOR EQUIPMENT

A. Provide titles consisting of vinyl film as specified above on all equipment using 1-in high Optima Bold upper case, Grid 2 spacing. Use white or black to provide high contrast to the substrate color. Use titles shown on mechanical drawings for bidding purposes. Mount titles at eye level on machines or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, number the items consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example, Pump No. 1, Pump No. 2, etc. Titles shall be composed in more than one line if required and justified on the left-hand side.

2.6 TESTING EQUIPMENT

A. Furnish wet and dry film thickness gauges, electronic moisture meter and all other equipment required by the Engineer for inspection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
   1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
      a. Concrete: 12 percent.
      b. Masonry (Clay and CMU): 12 percent.

B. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
   1. SSPC-SP 2.
   2. SSPC-SP 3.

3. SSPC-SP 7/NACE No. 4.
4. SSPC-SP 11.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

K. Mock-up: Provide a sample area of the finished work prepared in strict accordance with this Section to demonstrate the quality and workmanship of painting. When paint colors are required to match existing installed colors, provide as many paint manufacturer's warehouse mixed colors until accepted by the Engineer.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed to view:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Engineer, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 PAINTING SCHEDULE

A. Dry Film Thickness (DFT) for each paint product is not part of paint schedule. Submit both the Wet Film Thickness (WFT) and DFT for each product as part of submittal process. Apply paint and coating products to comply with manufacturer's DFT thickness and application recommendations in the approved submittal.

3.6 The following types of paints by Tnemec Co. (TN), The Sherwin Williams Company (SW), PPG Protective & Marine Coatings, (PPG), and Ameron International (AME) have been used as a basis for the paint schedule; use one of these paints or equal:

A. Epoxy:
1. TN:Hi-build Epoxoline II, Series N69.
2. SW: Macropoxy 646, B58 Series.
3. PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4. AME: Amerlock 2/400 Series Epoxy.

B. High-Build Acrylic Polyurethane Enamel:
1. TN:Endura-Shield - semi-gloss, Series V73.
2. SW: Acrolon 218 HS, B65 Series.
3. PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
4. AME: Amercoat 450HSG Polyurethane.

C. High Heat Silicone Aluminum (to 600 degrees F):
1. TN:No product.

2. SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series.
3. PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
4. AME: Amercoat 878 Silicone Aluminum Coating.

D. Tie Coat, Low VOC, Epoxy:
1. TN:FC Typoxy, Series V27.
2. SW: Macropoxy 646, B58 Series.
3. PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
4. AME: Amercoat 385 Multi-Purpose Epoxy.

E. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat as recommended by manufacturer:
1. Exterior non- submerged ferrous metals (except first coat-hollow metal-pressed metal work):
   a. First Coat: On properly prepared unprimed metal or for touch-up:
      1) TN: Hi-build Epoxoline II, Series N69.
      2) SW: Macropoxy 646, B58 Series.
      3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
      4) AME: Amerlock 2/400 Series Epoxy.
   b. Second Coat:
      1) TN: Hi-build Epoxoline II, Series N69.
      2) SW: Macropoxy 646, B58 Series.
      3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
      4) AME: Amerlock 2/400 Series Epoxy.
   c. Third Coat:
      1) TN: Endura-Shield - semi-gloss, Series V73.
      2) SW: Acrolon 218 HS, B65 Series.
      3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
      4) AME: Amercoat 450HSG Polyurethane.
2. Interior non-submerged concrete scheduled for painting:
   a. First and Second Coats:
      1) TN: Hi-build Epoxoline II, Series N69.
      2) SW: Macropoxy 646, B58 Series.
      3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
      4) AME: Amerlock 2/400 Series Epoxy.
3. Interior concrete masonry units:
   a. First Coat: Result in pinhole free surface.
      1) TN: No. 130-6602.
      2) SW: Cement-Plex 875, B42 Series.
      3) PPG: Cementitious Waterproofing Block Filler 95-217 Series.
      4) AME: Amerlock 400 BF Epoxy Block Filler.
   b. Second and Third Coats:
      1) TN: Hi-build Epoxoline II, Series N69.
      2) SW: Macropoxy 646, B58 Series.
      3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
      4) AME: Amerlock 2/400 Series Epoxy.
4. Interior non-submerged ferrous metals (except first coat of previously painted metal work), on properly prepared unprimed metal or for touch-up:
   a. First Coat:
      1) TN: Hi-build Epoxoline II, Series N69.
      2) SW: Macropoxy 646, B58 Series.

3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4) AME: Amerlock 2/400 Series Epoxy.

b. Second and Third Coats:
1) TN: Hi-build Epoxoline II, Series N69.
2) SW: Macropoxy 646, B58 Series.
3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4) PPG: Amerlock 2/400 Series Epoxy.

5. Submerged ferrous metals and ferrous metals subject to submersion or splashing. Surface shall be lightly sanded or abraded before application of first field coat.
a. First and Second Coats:
1) TN: Hi-build Epoxoline II, Series N69.
2) SW: Macropoxy 646, B58 Series.
3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4) PPG: Amerlock 2/400 Series Epoxy.

6. Plastic piping and, where scheduled to be painted, plastic components:
a. First and Second Coats:
1) TN: Hi-build Epoxoline II, Series N69.
2) SW: Macropoxy 646, B58 Series.
3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4) AME: Amerlock 2/400 Series Epoxy.

7. Previously painted existing concrete/CMU scheduled for painting:
a. First Coat:
1) TN: H.B. Tneme-Tufcoat, Series 113.
2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
3) PPG: Aquapon WB Epoxy 98-1 Series.
4) AME: Amercoat 335 WB Epoxy.

b. Second Coat:
1) TN: Enviro-Glaze, Series 297.
2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
3) PPG: Aquapon WB Epoxy 98-1 Series.
4) AME: Amercoat 335 WB Epoxy.

8. Existing precast concrete plank ceilings scheduled to be painted.
a. First and Second Coats:
1) TN: H.B. Tneme-Tufcoat, Series 113.
2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
3) PPG: Aquapon WB Epoxy 98-1 Series.
4) AME: Amercoat 335 WB Epoxy.

9. Pipe insulation: (Plastic or metal sheathed insulation-paint as scheduled for appropriate substrate):
a. First Coat:
1) TN: Vinyl-Acrylic Sealer, No. 51-792.
2) SW: Prep-Rite 200, B28 Series.
3) PPG: Speedhide 6-2 Vinyl Acrylic Drywall Primer.
4) AME: Amercoat 148 Acrylic Primer.

b. Second and Third Coats:
1) TN: Hi-build Epoxoline II, Series N69.
2) SW: Macropoxy 646, B58 Series.
3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
4) AME: Amerlock 2/400 Series Epoxy.

10. Aluminum Designated to be Painted:

a. Mechanically abrade surfaces to comply with SSPC SP 16 "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-ferrous Metals".
b. First and Second Coats - (Interior):
   1) TN: Hi-build Epoxoline II, Series N69.
   2) SW: Macropoxy 646, B58 Series.
   3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
   4) AME: Amerlock 2/400 Series Epoxy.
c. First Coat - (Exterior):
   1) TN: Hi-build Epoxoline II, Series N69.
   2) SW: Macropoxy 646, B58 Series.
   3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
   4) AME: Amerlock 2/400 Series Epoxy.
d. Second Coat - (Exterior):
   1) TN: Endura-Shield - semi-gloss, Series V73.
   2) SW: Acrolon 218 HS.
   3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
   4) AME: Amerlock 2/400 Series Epoxy.

11. Copper Piping:
    a. First and Second Coats:
       1) TN: Hi-build Epoxoline II, Series N69.
       2) SW: Macropoxy 646, B58 Series.
       3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
       4) AME: Amerlock 2/400 Series Epoxy.
12. Hot Ferrous Metal Surfaces:
    a. First and Second Coats:
       1) TN: No product.
       2) SW: Heat-Flex Hi-Temp 1000 Aluminum, B59-820 Series, Aluminum.
       3) PPG: Speedhide 6-220 Series Silicone Aluminum Coating.
       4) AME: Amercoat 878 Silicone Aluminum Coating.
13. Previously Painted Metal Surfaces:
    a. First coat on substrates prepared as approved and replacing first coat of above-specified systems. Complete painting with remainder of specified system for each type of substrate.
    b. First Coat:
       1) TN: FC Typoxy, Series V27.
       2) SW: Macropoxy 646, B58 Series.
       3) PPG: Pitt-Guard 97-145 Series Epoxy Mastic.
       4) AME: Amerlock 2/400 Series Epoxy.
14. Exterior galvanized steel surfaces:
    a. Mechanically abrade surfaces to comply with SSPC SP 16 "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-ferrous Metals".
    b. First Coat:
       1) TN: FC Typoxy, Series V27.
       2) SW: Macropoxy 646, B58 Series.
       3) PPG: Pitt-Guard Epoxy Mastic 95-245 Series.
       4) AME: Amercoat 385 Multi-Purpose Epoxy.
    c. Second Coat:
       1) TN: Endura-Shield - semi-gloss, Series V73.
       2) SW: Acrolon 218 HS.

3) PPG: Pitthane HB Semigloss Urethane 95-8800 Series.
4) AME: Amercoat 450HSG Polyurethane.

END OF SECTION 099100

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SECTION 101423.13 - ROOM-IDENTIFICATION SIGNAGE

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 room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification signs.
   1. Include fabrication and installation details and attachments to other work.
   2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
   3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Deterioration of finishes beyond normal weathering.
      b. Deterioration of embedded graphic image.
      c. Separation or delamination of sheet materials and components.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
   1. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
      a. Composite-Sheet Thickness: Manufacturer's standard for size of sign 0.25 inch.
      b. Surface-Applied Graphics: Applied photo image.
      c. Color(s): As selected by Engineer from manufacturer's full range.
   2. Sign-Panel Perimeter: Finish edges smooth.
      a. Edge Condition : Square cut.
      b. Corner Condition in Elevation: Square.
   3. Mounting: Manufacturer's standard method for substrates indicated with.
   4. Text and Typeface: Accessible raised characters and Braille Times Roman. Finish raised characters to contrast with background color, and finish Braille to match background color.
   5. Provide Room Identification sign at interior and exterior door. Four (4) total.

2.2 SIGN MATERIALS

A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

2.3 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
   1. Use concealed fasteners and anchors unless indicated to be exposed.
   2. For exterior exposure, furnish nonferrous-metal devices unless otherwise indicated.

B. Adhesive: As recommended by sign manufacturer.

2.4 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
   1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
   2. Install signs so they do not protrude or obstruct according to the accessibility standard.
   3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:
   1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.13

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SECTION 104416 - FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Owner-Furnished Material: Hand-carried fire extinguishers.

C. Related Requirements:
   1. Section 104413 "Fire Protection Cabinets."
   2. Section 233813 "Commercial-Kitchen Hoods" for fire-extinguishing systems provided as part of commercial-kitchen exhaust hoods.

1.3 UNIT PRICES

A. Work of this Section is affected by.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.5 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.7 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Failure of hydrostatic test according to NFPA 10.
      b. Faulty operation of valves or release levers.
   2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   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. JL Industries, Inc.; a division of the Activar Construction Products Group.
      b. Kidde Residential and Commercial Division.
   2. Valves: Manufacturer's standard.
   3. Handles and Levers: Manufacturer's standard.
   4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 10-A:120-B:C, 20-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.
   1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
      a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
   1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

C. Verify that each fire extinguisher is present at Substantial Completion. Replace missing fire extinguishers with new to match specified product at no additional cost to District.

END OF SECTION 104416

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SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

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. Sleeves.
   2. Sleeve-seal systems.
   3. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

A. Description:
   1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   2. Designed to form a hydrostatic seal of 20 psig minimum.
   3. Sealing Elements: EPDM-rubber, High-temperature-silicone, or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
   4. Pressure Plates: Carbon steel.
   5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.
   2. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

D. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping NPS 6 and Smaller: Steel pipe sleeves.
   2. Concrete Slabs-on-Grade:
      a. Piping NPS 6 and Smaller: Steel pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Interior Partitions:
      a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION 210517

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SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

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. Escutcheons.
   2. Floor plates.

1.3 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. One-piece steel with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION 210518

SECTION 210523 - GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

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. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
   1. Main Level: HAMV - Fire Main Equipment.
      a. Level 1: HCBZ - Indicator Posts, Gate Valve.
      b. Level 1: HLOT - Valves.
         1) Level 3: HLUG - Ball Valves, System Control.
         2) Level 3: HLXS - Butterfly Valves.
         3) Level 3: HMER - Check Valves.
         4) Level 3: HMRZ - Gate Valves.
   2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
      a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
   1. Automated Sprinkler Systems:
      a. Indicator posts.
      b. Valves.
         1) Gate valves.
         2) Check valves.
            a) Single check valves.
         3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B1.20.1 for threads for threaded-end valves.
   3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:
   1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
   2. Handwheel: For other than quarter-turn trim and drain valves.
   3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:
   1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
   2. Minimum Pressure Rating: 175 psig.
   3. Body Design: Two piece.
   4. Body Material: Forged brass or bronze.
   5. Port Size: Full or standard.
   6. Seats: PTFE.
   7. Stem: Bronze or stainless steel.
   8. Ball: Chrome-plated brass.
   9. Actuator: Worm gear or traveling nut.
   10. Supervisory Switch: Internal or external.
   11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
   12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Description:
   1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
   2. Minimum: Pressure rating: 175 psig.
   3. Body Material: Bronze.
   4. Seat Material: EPDM.
   5. Stem Material: Bronze or stainless steel.
   6. Disc: Bronze or Stainless steel with EPDM coating.
   7. Actuator: Worm gear or traveling nut.
   8. Supervisory Switch: Internal or external.
   9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
   10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:
   1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
   2. Minimum Pressure Rating: 175 psig.
   3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
   4. Seat Material: EPDM.
   5. Stem: Stainless steel.
   6. Disc: Ductile iron, nickel plated and EPDM or SBR coated.

7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Grooved-end connections.

2.5 CHECK VALVES

A. Description:
1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

A. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

A. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Grooved or Threaded.

2.8 NRS GATE VALVES

A. Description:
1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Grooved or Threaded.

2.9 INDICATOR POSTS

A. Description:
1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Underground or Wall.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Wrench or Handwheel.

2.10 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Description:
a. Pressure Rating: 175 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:
1. Description:
a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Material: Bronze with integral seat and screw-in bonnet.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc Holder and Nut: Bronze.
      f. Disc Seat: Nitrile.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
   1. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 210523

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SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
   2. Fastener systems.
   3. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

B. NFPA Compliance: Comply with NFPA 13.

C. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   2. Coatings: PVC.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   2. Indoor Applications: Zinc-coated or Stainless steel.

2.4 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.5 MATERIALS

A. Carbon Steel: ASTM A 1011/A 1011M.

B. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A 240/A 240M.

D. Grout: ASTM C 1107/C 1107M, factory-mixed and packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
   2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

E. Install lateral bracing with pipe hangers and supports to prevent swaying.

F. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

G. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

E. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

F. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of stationary pipes NPS 1/2 to NPS 30.
   2. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

H. Hanger-Rod Attachments: Comply with NFPA requirements.

I. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. C-Clamps (MSS Type 23): For structural shapes.
   3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 210529

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

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. Equipment labels.
   2. Pipe labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Brimar Industries, Inc.
      c. Carlton Industries, LP.
   2. Material and Thickness: Brass, 0.032 inch; stainless steel, 0.025 inch; aluminum, 0.032 inch; or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
   3. Letter Color: Black or White.
   4. Background Color: Black or White.
   5. Letter and Background Color shall be different.
   6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering

for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Carlton Industries, LP.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter Color: Black or White.
4. Background Color: Black or White.
5. Letter and Background Color shall be different.
6. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
8. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
9. Fasteners: Stainless-steel rivets or self-tapping screws.
10. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover or cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: Size letters according to ASME A13.1 for piping.

F. Pipe-Label Colors:
   1. Background Color: Safety Red.
   2. Letter Color: White.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit a view of concealed piping.

5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

END OF SECTION 210553

SECTION 211119 – FIRE DEPARTMENT CONNECTIONS

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. Exposed-type fire-department connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Elkhart Brass Mfg. Co., Inc.
   2. Fire Protection Products, Inc.
   3. Guardian Fire Equipment, Inc.

B. Standard: UL 405.

C. Type: Exposed, projecting, for wall mounting.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Round, brass, wall type.

I. Outlet: Back, with pipe threads.

J. Number of Inlets: Two.

K. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."

L. Finish: Polished chrome plated.

M. Outlet Size: NPS 4, NPS 5, or NPS 6.

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 fire-department connections.

B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.

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

3.2 INSTALLATION

A. Install wall-type fire-department connections.

B. Install two protective pipe bollards on sides of each fire-department connection.

C. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 211119

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

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. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Control panels.
6. Pressure gages.

B. Related Requirements:
1. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

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

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Domestic water piping.
   2. HVAC duct.
   3. Lighting fixtures.

B. Qualification Data: For qualified Installer.

C. Design Data:
   1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:
   1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
   2. Fire-hydrant flow test report.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or designer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.
   1. Sprinkler system design shall be approved by authorities having jurisdiction.
      a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
      b. Sprinkler Occupancy Hazard Classifications:
         1) Per Drawings.
   2. Minimum Density for Automatic-Sprinkler Piping Design:
      a. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
   3. Maximum Protection Area per Sprinkler: According to UL listing.
   4. Maximum Protection Area per Sprinkler:
      a. According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M,. Pipe ends may be factory or field formed to match joining method.

B. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

C. Galvanized- and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

D. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Malleable- or Ductile-Iron Unions: UL 860.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
   1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick; ASME B16.21, nonmetallic and asbestos free, or EPDM rubber gasket.
      a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
      b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
   2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Pressure Rating: 175-psig minimum.
   2. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
   3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:
   1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
   2. High-Pressure Piping Specialty Valves: 250-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco by Johnson Controls Company.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 193.
   3. Design: For horizontal or vertical installation.
   4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
   5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
   6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
   7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Automatic (Ball Drip) Drain Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable Automatic Sprinkler Co., Inc. (The).
      b. Tyco by Johnson Controls Company.
      c. Viking Corporation.
   2. Standard: UL 1726.
   3. Pressure Rating: 175-psig minimum.

4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc. (The).
   b. Tyco by Johnson Controls Company.
   c. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elkhart Brass Mfg. Co., Inc.
   b. Fire-End & Croker Corporation.
   c. Potter Electric Signal Company, LLC.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Tyco by Johnson Controls Company.
   b. Victaulic Company.
   c. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.5 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Reliable Automatic Sprinkler Co., Inc. (The).
2. Tyco by Johnson Controls Company.
3. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

D. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

E. Sprinkler Finishes: electroless nickel PTFE.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat or Chrome-plated steel, two piece, with 1-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

G. Sprinkler Guards:
1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Globe Fire Sprinkler Corporation.
      b. Tyco by Johnson Controls Company.
      c. Victaulic Company.
      d. Viking Corporation.
   2. Standard: UL 753.
   3. Type: Mechanically operated, with Pelton wheel.
   4. Alarm Gong: Cast aluminum with red-enamel factory finish.
   5. Size: 8-1/2-inches diameter.
   6. Components: Shaft length, bearings, and sleeve to suit wall construction.
   7. Inlet: NPS 3/4.
   8. Outlet: NPS 1 drain connection.
   9. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Globe Fire Sprinkler Corporation.
      b. Tyco by Johnson Controls Company.
      c. Victaulic Company.
      d. Viking Corporation.
   10. Standard: UL 464.
   11. Type: Vibrating, metal alarm bell.
   12. Size: 6-inch minimum- diameter.
   13. Finish: Red-enamel factory finish, suitable for outdoor use.
   14. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Electrically Operated Alarm Bell:
   1. Standard: UL 464.
   2. Type: Vibrating, metal alarm bell.
   3. Size: 8-inch minimum- diameter.
   4. Finish: Red-enamel factory finish, suitable for outdoor use.
   5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Water-Flow Indicators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Potter Electric Signal Company, LLC.
      b. System Sensor.
      c. Viking Corporation.
   2. Standard: UL 346.
   3. Water-Flow Detector: Electrically supervised.
   4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   5. Type: Paddle operated.
   6. Pressure Rating: 250 psig.

7. Design Installation: Horizontal or vertical.

E. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Potter Electric Signal Company, LLC.
b. System Sensor.
c. Tyco by Johnson Controls Company.
d. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Fire-Lite Alarms, Inc.; a Honeywell International company.
b. Kennedy Valve Company; a division of McWane, Inc.
c. Potter Electric Signal Company, LLC.
d. System Sensor.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AGF Manufacturing, Inc.
2. AMETEK, Inc.
3. Ashcroft Inc.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Engineer before deviating from approved working plans.
   2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

J. Install alarm devices in piping systems.

K. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they are not subject to freezing.

M. Fill sprinkler system piping with water.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:
1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

A. Install sprinklers according to NFPA 13.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints; or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Wall Mounting: Sidewall sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Upright Pendent and Sidewall Sprinklers: electroless nickel PTFE.

END OF SECTION 211313

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

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. Sleeves.
   2. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

A. Description:
   1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   2. Designed to form a hydrostatic seal of 20 psig minimum.
   3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   4. Pressure Plates: Carbon steel.
   5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

D. Fire-Resistance-Rated Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE SCHEDULE

A. Use sleeves for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Steel pipe sleeves.
   2. Concrete Slabs-on-Grade:
      a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.
         1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Interior Partitions:
      a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION 220517

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SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

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. Escutcheons.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. One-piece steel with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION 220518

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SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

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. Bronze ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and soldered ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.18 for solder-joint connections.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
1. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. Hammond Valve.
c. NIBCO INC.
2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded or soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and

handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.4 DOMESTIC HOT- AND COLD-WATER AND PROTECTED WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze ball valves, two-piece with full port and stainless-steel trim.

END OF SECTION 220523.12

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
   2. Thermal hanger-shield inserts.
   3. Fastener systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Coatings: PVC.
   3. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   4. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 THERMAL HANGER-SHIELD INSERTS

A. Manufacturer: Buckaroos, Inc.; Pipe Shields Inc.; Value Engineered Products Inc.

B. Insulation Insert Material for Cold Piping: use either or.

C. Insulation Insert Material for Hot Piping: use either or.

D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Buckaroos, Inc.
   2. CADDY; a brand of nVent.
   3. Pipe Shields Inc.

E. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

F. For Clamped Systems: Insert and shield shall cover entire circumference of pipe.

G. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

H. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Hilti, Inc.
      c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   2. Indoor Applications: Zinc-coated or stainless steel.

2.5 MATERIALS

A. Carbon Steel: ASTM A 1011/A 1011M.

B. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A 240/A 240M.

D. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Install hangers and supports to allow controlled thermal movement of piping systems and to permit freedom of movement between pipe anchors.

F. Install lateral bracing with pipe hangers and supports to prevent swaying.

G. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

I. Insulated Piping:
   1. Attach clamps and spacers to piping.

a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal hanger-shield inserts may be used.
3. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
4. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use PVC-coated carbon-steel or stainless-steel pipe hangers and supports.

D. Use thermal hanger-shield inserts for insulated piping and tubing.

E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

F. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

G. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
2. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

J. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

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. Equipment labels.
   2. Pipe labels.

1.3 ACTION SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. Brimar Industries, Inc.
      c. Carlton Industries, LP.
   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick and having predrilled holes for attachment hardware.
   3. Letter Color: Black or White.
   4. Background Color: Black or White.
   5. Letter and Background color shall be different.
   6. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

7. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
8. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
9. Fasteners: Stainless-steel rivets or self-tapping screws.
10. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25 along each run. Reduce intervals to 15 in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:
   1. Domestic Water Piping:
      a. Background: Safety green.
      b. Letter Colors: White.
   2. Protected Water Piping:
      a. Background: Safety green.
      b. Letter Colors: White.
   3. Process Drain and Sanitary Waste Piping:
      a. Background Color: Safety black.
      b. Letter Color: White.
   4. Sump Pump Discharge (Sanitary and Chemical):
   5. Background Color: Safety black.
      a. Letter Color: White.

END OF SECTION 220553

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SECTION 220719 - PLUMBING PIPING INSULATION

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 insulating the following plumbing piping services:
   1. Domestic, Tempered, and Protected water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   3. Detail application of field-applied jackets.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General" and "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Pittsburgh Corning Corporation.
   2. Preformed Pipe Insulation with Factory-Applied ASJ or ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
   1. Pittsuurgh Corning: PC 88 Adhesive
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Foster Brand; H. B. Fuller Construction Products.

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Mon-Eco Industries, Inc.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Knauf Insulation.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Vimasco Corporation.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants for Cellular-Glass Products:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.

c. Pittsburgh Corning Corporation.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. ASJ Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Knauf Insulation.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
   4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
   5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
   6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
   7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
   8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
   9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of cellular-glass insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.7 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of threaded valves, for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic and Protected Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Cellular Glass: 1-1/2 inches thick.

END OF SECTION 220719

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SECTION 221116 - DOMESTIC WATER PIPING

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. Copper tube and fittings.
   2. Piping joining materials.
   3. Transition fittings.
   4. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For copper tube, joining materials, transition fittings, and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

D. Copper Unions:
1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys.

B. Flux: ASTM B 813, water flushable.

2.4 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Standard: ASSE 1079.
2. Pressure Rating: 125 psig minimum at 180 deg F.
3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
1. Standard: ASSE 1079.
2. Factory-fabricated, bolted, companion-flange assembly.
3. Pressure Rating: 125 psig minimum at 180 deg F.

4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
1. Nonconducting materials for field assembly of companion flanges.
2. Pressure Rating: 150 psig.
3. Gasket: Neoprene or phenolic.
4. Bolt Sleeves: Phenolic or polyethylene.
5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F 1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve immediately upstream of each dielectric fitting.

C. Install domestic water piping level and plumb.

D. Install piping to permit valve servicing.

E. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers and supports for domestic water piping at spacing requirements per the International Plumbing Code.

E. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Equipment: Cold- and protected-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
      e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
      f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   5. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Aboveground domestic water piping shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and soldered joints.

3.11 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller.

END OF SECTION 221116

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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. Backflow preventers.
   2. Water pressure-reducing valves.
   3. Water-hammer arresters.
   4. Water meters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Flow Controls; Conbraco Industries, Inc.
   b. WATTS.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 15 psig maximum, through middle third of flow range.
5. Size: as shown on drawings.
6. Body: Bronze for NPS 2 and smaller.
7. End Connections: Threaded for NPS 2 and smaller.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
   c. Strainer

2.4 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
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. Apollo Flow Controls; Conbraco Industries, Inc.
   b. WATTS.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: per Drawings.
5. Design Inlet Pressure: 105 psig.
6. Design Outlet Pressure Setting: per Drawings.
7. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
8. Valves for Booster Heater Water Supply: Include integral bypass.
9. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.5 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. WATTS.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.

4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.6 WATER METERS

A. Displacement-Type Water Meters:
   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. Neptune
      b. Badger
      c. Sensus
   2. Description:
      a. Standard: AWWA C700.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: Nutating disc; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. End Connections: Threaded.
      g. Transmitter: 4-20mA

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers as shown on the Drawings. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.

B. Install water-hammer arresters in water piping according to PDI-WH 201.

3.2 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Reduced-pressure-principle backflow preventers.
   2. Water pressure-reducing valves.

B. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

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. PVC pipe and fittings.
   2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For drainage system. Include plans, elevations, sections, and details.

C. Field quality-control reports.

1.4 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent, Schedule 80.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 80 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   2. Shielded, Nonpressure Transition Couplings:
      a. Standard: ASTM C 1460.
      b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
      c. End Connections: Same size as and compatible with pipes to be joined.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

C. Install piping to permit valve servicing.

D. Install piping at indicated slopes.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
   2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

I. Install soil and waste and vent piping at the minimum slopes required by the plumbing code.

J. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

K. Install aboveground PVC piping according to ASTM D 2665.

L. Install engineered soil and waste and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

M. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.2 JOINT CONSTRUCTION

A. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
   1. Cut threads full and clean using sharp dies.
   2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
      a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
      c. Do not use pipe sections that have cracked or open welds.

B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

C. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.
   2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42, clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS SP-58 Type 38 adjustable pipe saddle supports.

B. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

C. Install hangers and supports for sanitary waste and vent piping at spacing requirements per the International Plumbing Code.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
      b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      c. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
      b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      d. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

3.7 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.8 PIPING SCHEDULE

A. Soil and waste piping, and pumped discharge (sanitary and chemical) shall be the following:

   1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

END OF SECTION 221316

SECTION 221429 - SUMP PUMPS

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. Submersible sump pumps.
   2. Sump-pump basins and basin covers.

B. Related Requirements:
   1. Section 220513 “Common Motor Requirements for Plumbing Equipment” for motor requirements.
   2. Section 262505 “480V Control Panels” for control panel requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Barnes; a Crane Pumps & Systems brand.
      b. Weil Pump Company, Inc.
      c. Zoeller Company.
   2. Description: Factory-assembled and -tested sump-pump unit.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
   4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   5. Impeller: Statically and dynamically balanced, ASTM B 584, cast bronze, design for clear wastewater handling, and keyed and secured to shaft.
   6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
   7. Seal: Mechanical.
   8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   9. Controls:
      a. Enclosure: NEMA 250, Type 4X; wall mounted.
      b. Switch Type: Manual selector.
      c. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float or pressure switch matching control and electric bell; 120 V ac, with transformer and contacts for remote alarm bell.
   10. Control-Interface Features:
      a. Remote Alarm Contacts: For remote alarm interface.
      b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
         1) On-off status of pump.
         2) Alarm status.

2.2 SUMP-PUMP CAPACITIES AND CHARACTERISTICS

A. Refer to schedule on Drawings.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Performs startup service.
   1. Complete installation and startup checks, according to manufacturer's written instructions.

3.6 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221429

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

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. Commercial, direct-vent, gas-fired, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within standard warranty period.

PART 2 - PRODUCTS

2.1 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Direct-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A. O. Smith Corporation.

b. Bradford White Corporation.
c. Rheem Manufacturing Company.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: ANSI Z21.10.3/CSA 4.1.
4. Storage-Tank Construction: Steel.
   a. Tappings: ASME B1.20.1 pipe thread
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.
5. Factory-Installed Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Burner: For use with direct-vent, gas-fired, domestic-water heaters and natural-gas fuel.
   h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
   i. Temperature Control: Adjustable thermostat.
   j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valve with sensing element that extends into storage tank.
6. Direct-Vent System: Through- roof, coaxial- or double-channel vent assembly with domestic-water heater manufacturers' outside intake/exhaust screen.

B. Capacity and Characteristics:
1. Refer to schedule on Drawings.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:
1. Basis of Design: Amtrol ThermXtrol.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. A. O. Smith Corporation.
   b. AMTROL, Inc.
   c. TACO Comfort Solutions, Inc.
3. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
4. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
5. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

6. Capacity and Characteristics:
a. Refer to schedule on Drawings.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Comply with requirements for ball valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."

F. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.

G. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Pressure rating as required to match gas supply.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.

J. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.

4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."

C. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.

F. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill domestic-water heaters with water.

H. Charge domestic-water expansion tanks with air to required system pressure.

I. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

END OF SECTION 223400

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SECTION 224216.16 - COMMERCIAL SINKS

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. Mop Sinks.
   2. Supply fittings.
   3. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
   2. Include rated capacities, operating characteristics and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 MOP SINKS

A. Service Basins: stainless steel, floor mounted.
   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. Elkay Manufacturing Co.
      b. Kohler Co.
      c. Zurn Industries, LLC.
   2. Fixture:
      a. Shape: Rectangular.
      b. Nominal Size: 25 by 23 inches.
      c. Height: 8 inches.
      d. Drain: Grid with NPS 3 outlet.
   3. Mounting: On floor and flush to wall.

B. Faucet: Manual type, two-lever-handle mixing valve.
   1. Commercial, Solid-Brass Faucets.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1) Elkay Manufacturing Co.
   2) Kohler Co.
   3) Zurn Industries, LLC.

2. Standard: ASME A112.18.1/CSA B125.1.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
4. Body Type: Centerset.
5. Body Material: Commercial, solid brass.
6. Finish: Chrome plated.
7. Maximum Flow Rate: 4.0 gpm.
8. Handle(s): Lever.
9. Mounting Type: Back/wall, exposed.
10. Spout Type: Rigid, solid brass with wall brace.
11. Vacuum Breaker: Required for hose outlet.
12. Spout Outlet: Hose thread according to ASME B1.20.7.

2.2 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

2.3 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:
   1. Size: NPS 3.
   2. Material: chrome-plated brass.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls and floors for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Set floor-mounted sinks in leveling bed of cement grout.

D. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
   2. Install stops in locations where they can be easily reached for operation.

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

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. Combination units.
   2. Supplemental equipment.
   3. Water-tempering equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

D. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standard: Comply with ISEA Z358.1.

C. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.

2.2 COMBINATION UNITS

A. Standard, Plumbed Emergency Shower with Eye/Face Wash Combination Units,:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley Corporation.
      b. Guardian Equipment Co.
      c. Haws Corporation.
   2. Piping:
      a. Material: PVC or stainless steel.
      b. Unit Supply: NPS 1-1/4 minimum.
      c. Unit Drain: Outlet at back or side near bottom.
   3. Shower:
      a. Capacity: Not less than 20 gpm for at least 15 minutes.
      b. Control-Valve Actuator: Pull rod.
      c. Shower Head: 8-inch- minimum diameter, chrome-plated brass or stainless steel.
      d. Mounting: Pedestal.
   4. Eye/Face Wash Unit:
      a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
      b. Control-Valve Actuator: Paddle.
      c. Spray-Head Assembly: Two or four receptor-mounted spray heads.
      d. Receptor: Chrome-plated brass or stainless-steel bowl.
      e. Mounting: Attached shower pedestal.
   5. Appurtenances:
      a. Flow Switch and Alarm with remote contacts.

B. Freeze-Protected, Plumbed Emergency Shower with Eyewash Combination Units,:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley Corporation.
      b. Guardian Equipment Co.
      c. Haws Corporation.
   2. Piping: Galvanized steel.
      a. Unit Supply: NPS 1-1/4 minimum from top.
   3. Heating System: Electric, 120 V ac; insulation enclosed in a protective jacket with thermometer.
   4. Shower:

a. Shower Capacity: Not less than 20 gpm for at least 15 minutes.
b. Control-Valve Actuator: Pull rod.
c. Shower Head: 8-inch- minimum diameter, chrome-plated brass or stainless steel.
d. Mounting: Pedestal.

5. Eye/Face Wash Unit:
   a. Capacity: Not less than 3 gpm for at least 15 minutes.
   b. Control-Valve Actuator: Paddle.
6. Appurtenances:
   a. Flow Switch and Alarm with remote contacts.

2.3 WATER-TEMPERING EQUIPMENT

A. Hot- and Cold-Water, Water-Tempering Equipment,:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley Corporation.
      b. Guardian Equipment Co.
      c. Haws Corporation.
      d. Leonard Valve Company.
      e. WATTS.
   2. Description: Factory-fabricated equipment with thermostatic mixing valve.
      a. Thermostatic Mixing Valve: Designed to provide tepid, potable water at emergency plumbing fixtures, to maintain temperature throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
      b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be

reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping".

1. Exception: Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment.

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:
1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION 224500

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Match insulation rating.

G. Insulation: Class F.

H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Capacitor start, capacitor run.

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Washdown duty: Where motor is installed in wet or corrosive areas routinely exposed to washdowns, high humidity or caustic chemicals, provide stainless steel, paint free washdown motors with Inpro bearing isolators, stainless steel T-type condensation drains, nitrile conduit box gasket, and corrosion resistant fans.

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230513

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

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. Equipment labels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   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. Brady Corporation.
      b. Brimar Industries, Inc.
      c. Carlton Industries, LP.
   2. Material and Thickness: Brass, 0.032-inch; stainless steel, 0.025-inch; aluminum, 0.032-inch; or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   3. Letter Color: Black or White.
   4. Background Color: White or Black.
   5. Letter and Background Color shall be different.
   6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering

for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

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. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Testing, Adjusting, and Balancing Equipment:
      a. Motors.
      b. Condensing units.
   3. Duct leakage tests.
   4. Control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 3 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB, or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine 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 curves.
   1. 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.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine operating safety interlocks and controls on HVAC equipment.

J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:
   1. Equipment and systems to be tested.
   2. Strategies and step-by-step procedures for balancing the systems.
   3. Instrumentation to be used.

4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete, and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing", and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation."

C. Mark equipment and balancing devices, including damper-control positions, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
      c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
      d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
   4. Obtain approval from Engineer or Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
   5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.

3.6 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer's name, model number, and serial number.
   2. Motor horsepower rating.
   3. Motor rpm.
   4. Phase and hertz.
   5. Nameplate and measured voltage, each phase.
   6. Nameplate and measured amperage, each phase.
   7. Starter size and thermal-protection-element rating.
   8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.7 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.8 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.9 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
   1. Verify temperature control system is operating within the design limitations.
   2. Confirm that the sequences of operation are in compliance with Contract Documents.
   3. Verify that controllers are calibrated and function as intended.
   4. Verify that controller set points are as indicated.
   5. Verify the operation of lockout or interlock systems.
   6. Verify the operation of damper actuators.
   7. Verify that controlled devices are properly installed and connected to correct controller.
   8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
   9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.10 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.11 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to 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; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of TAB supervisor who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. Summary of contents including the following:
    a. Indicated 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's name, type, size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for fan performance forms including the following:
    a. Settings for outdoor-, 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. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Terminal units.
4. Balancing stations.
5. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    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, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor 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, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Heating section static-pressure differential in inches wg.
   g. Outdoor airflow in cfm.
   h. Return airflow in cfm.
   i. Outdoor-air damper position.
   j. Return-air damper position.

F. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btu/h.
   h. Ignition type.
   i. Burner-control types.
   j. Motor horsepower and rpm.
   k. Motor volts, phase, and hertz.
   l. Motor full-load amperage and service factor.
   m. Sheave make, size in inches, and bore.
   n. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Entering-air temperature in deg F.
   c. Leaving-air temperature in deg F.
   d. Air temperature differential in deg F.
   e. Entering-air static pressure in inches wg.
   f. Leaving-air static pressure in inches wg.
   g. Air static-pressure differential in inches wg.

h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
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, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
a. Motor 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, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. 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:
a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:
1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer may conduct the inspection in the presence of Engineer or Owner.

B. Engineer or Owner may randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, Owner or Engineer may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions if requested.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

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 insulating the following duct services:
   1. Indoor, exposed supply and outdoor air.

B. Related Sections:
   1. Section 233113 "Metal Ducts".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate clearance requirements with duct Installer for duct insulation application. Establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   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. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

E. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   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. CertainTeed Corporation.
      b. Johns Manville; a Berkshire Hathaway company.
      c. Knauf Insulation.
      d. Manson Insulation Inc.
      e. Owens Corning.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   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. Childers Brand; H. B. Fuller Construction Products.
      b. Eagle Bridges - Marathon Industries.
      c. Foster Brand; H. B. Fuller Construction Products.
      d. Mon-Eco Industries, Inc.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   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. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Knauf Insulation.
      d. Vimasco Corporation.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   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. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Vimasco Corporation.
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Color: White.

2.5 SEALANTS

A. FSK Jacket Flashing Sealants:
   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. Childers Brand; H. B. Fuller Construction Products.
      b. Eagle Bridges - Marathon Industries.
      c. Foster Brand; H. B. Fuller Construction Products.
      d. Mon-Eco Industries, Inc.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

2.8 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   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. Avery Dennison Corporation, Specialty Tapes Division.
      b. Compac Corporation.
      c. Ideal Tape Co., Inc., an American Biltrite Company.
      d. Knauf Insulation.
      e. Venture Tape.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.9 SECUREMENTS

A. Bands:
   1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      b. Spindle: Copper- or zinc-coated, low-carbon steel, aluminum, or stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
      c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   4. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      b. Spindle: Copper- or zinc-coated, low-carbon steel, aluminum, or stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
      c. Adhesive-backed base with a peel-off protective cover.
   5. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel, aluminum, or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
   6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, exposed supply and outdoor air.

B. Exposed, round, supply and outdoor air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Exposed, rectangular, supply and outdoor air duct insulation shall be the following:
   1. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

D. Items Not Insulated:
   1. Flexible connectors.
   2. Factory-insulated access panels and doors.

END OF SECTION 230713

SECTION 230933 – ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

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. ATC system for controlling of HVAC systems.

B. Related Requirements:
   1. Section 233300 "Air Duct Accessories."
   2. Section 260523 "Control-Voltage Electrical Power Cables."
   3. Section 260533 "Raceways and Boxes for Electrical Systems."
   4. Section 260553 "Identification for Electrical Systems.

C. Furnish and install a complete electric automatic temperature control system as manufactured by Johnson Controls, Schneider Electric, or Automated Logic Corporation.

D. Control system shall consist of all thermostats, temperature switches, flow switches, automatic dampers, damper operators, control panels, electric relays, and other accessory equipment along with a complete system of electrical wiring to fill the intent of the specification and provide for a complete and operable system.

1.3 DEFINITIONS

A. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

B. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

C. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:
   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.
   4. Installation, operation and maintenance instructions including factors effecting performance.
   5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
      a. Enclosures.
      b. Electrical power devices.
      c. Instruments.
      d. Control dampers and actuators.
   6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
   7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

B. Shop Drawings:
   1. General Requirements:
      a. Include cover drawing with Project name, location, Owner, Engineer, Contractor and issue date with each Shop Drawings submission.
      b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
      c. Drawings Size: 11”x17”.
   2. Include plans, elevations, sections, and mounting details where applicable.
   3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   4. Schematic drawings for each controlled HVAC system indicating the following:
      a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper.
      b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
      c. A graphic showing location of control I/O in proper relationship to HVAC system.
      d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
      e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
      f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to ATC controllers.
      g. Narrative sequence of operation.
      h. Graphic sequence of operation, showing all inputs and output logical blocks.
   5. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
c. Front, rear, and side elevations and nameplate legend.
d. Unique drawing for each panel.

6. ATC system electrical power riser diagram indicating the following:
   a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
   b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
   c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
   d. Power wiring type and size, race type, and size for each.

1.5 DELEGATED-DESIGN SUBMITTAL

A. For ATC system products and installation indicated as being delegated.
   1. Supporting documentation showing ATC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For ATC system to include in emergency, operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.

PART 2 - PRODUCTS

2.1 ATC SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ATC system to satisfy requirements indicated.

B. Surface-Burning Characteristics: Products installed in ducts and equipment shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
   a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
   a. Outdoors: Type 4 or Type 4X.
   b. Chemical storage rooms: Type 4X.

D. Continuity of Operation after Electric Power Interruption:
1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.3 ENCLOSURES

A. General Enclosure Requirements:
1. House each controller and associated control accessories in an enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 60 inches high.
6. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
8. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect electric and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:
1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall Mounted NEMA 250, Types 4 and 12:
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. Hoffman; a brand of nVent.
2. Enclosure shall be NRTL listed according to UL 508A.

3. Seam and joints are continuously welded and ground smooth.
4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
7. Construct enclosure of steel, not less than the following:
   a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
   b. Size 24 Inches and Larger: 0.067 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
   a. Sizes through 24 Inches Tall: Two hinges.
   b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
   c. Sizes Larger 48 Inches Tall: Four hinges.
10. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
11. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
12. Grounding stud on enclosure body.
13. Thermoplastic pocket on inside of door for record Drawings and Product Data.

2.4 ELECTRONIC DAMPER ACTUATORS

A. Electronic actuators, less than 600 in.-lb. of rated torque, must have ISO 9001 quality certification and be UL listed under standard 873, CSA C22.2 No. 24 and have CE certification. Electronic actuators used on valves must be designed to directly couple and mount to a stem, shaft or ISO style-mounting pad. Actuator mounting clamps must be a V-bolt with a toothed V-clamp creating a cold weld, positive grip effect. Single point, bolt or single screw actuator type fastening techniques or direct-coupled actuators requiring field assembly of the universal clamp is not acceptable.

B. Actuators must be two position and have visual position indicators and must operate in sequence with other devices if required.

C. Actuator must have an operating range of minus 22 to 122 degrees F.

D. Actuators must be capable of operating on 24 VAC/VDC or 120 VAC. Power consumption must not exceed 10 VA for AC, including 120 VAC actuators and 8 watts per actuator for applications.

E. Actuators must have electronic overload protection or digital rotation sensing circuitry to prevent actuator damage throughout the entire rotation. End switches to deactivate the actuator at the end of rotation or magnetic clutches are not acceptable.

F. For power-failure/safety applications, an internal mechanical spring return mechanism must be built into the actuator housing. Spring return actuators must be capable of CW or CCW mounting orientation. Spring return models >60 in.-lb. will be capable of mounting on shafts up to 1.05-in. diameter. Spring return actuators with more than 60 in.-lb. of torque must have a manual override metal crank. Upon loss of control signal, a proportional actuator must fail open

or closed based on the minimum control signal. Upon loss of power, a non-spring return actuator must maintain the last position.

G. Actuators must be capable of being mechanically and electrically paralleled to increase torque if required. Dampers requiring greater torque or higher close off may be assembled with multiple low torque actuators. Dual mounted actuators using additional anti-rotation strap mechanical linkages or special factory wiring to function are not acceptable. Actuators in a tandem pair must be "off the shelf" standard actuators ready for field wiring.

H. Damper actuators must not produce more than 62 dbA when furnished with a mechanical fail-safe spring. Non-spring return actuators must conform to a maximum noise rating of 45 dbA with power on or in the running or driving mode.

I. Damper actuators must be furnished with NEMA 4X enclosures and must have a shaft seal and all electrical connections must be suitable for the space classification. Enclosure must be UL listed

2.5 RELAYS

A. General-Purpose Relays:
   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. Omron.
      b. Schneider Electric.
      c. Siemens Industry, Inc., Building Technologies Division.
   2. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
   3. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
   4. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
   5. Construct the contacts of either silver cadmium oxide or gold.
   6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
   7. Relays shall have LED indication and a manual reset and push-to-test button.
   8. Performance:
      a. Mechanical Life: At least 10 million cycles.
      b. Electrical Life: At least 100,000 cycles at rated load.
      c. Pickup Time: 15 ms or less.
      d. Dropout Time: 10 ms or less.
      e. Pull-in Voltage: 85 percent of rated voltage.
      f. Dropout Voltage: 50 percent of nominal rated voltage.
      g. Power Consumption: 2 VA.
      h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
   9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
   10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
   11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

2.6 ELECTRICAL POWER DEVICES

A. Transformers:
   1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
   2. Transformer shall be at least 40 VA.
   3. Transformer shall have both primary and secondary fuses.

2.7 CONTROL WIRE AND CABLE

A. Field wiring between ATC panels, control devices, unitary control panel, and HVAC equipment controllers shall be furnished under this Section and shall conform to the requirements of Division 26.

B. Wire: Single conductor control wiring above 24 V.
   1. Wire size shall be at least No. 18 AWG.
   2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
   3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
   4. Conductor colors shall be black (hot), white (neutral), and green (ground).
   5. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable above 24 V:
   1. Wire size shall be a minimum No. 20 AWG.
   2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
   3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
   4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
   5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
   6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
   7. Furnish wire on spools.

D. Single Twisted Shielded Instrumentation Cable 24 V and Less:
   1. Wire size shall be a minimum No. 20 AWG.
   2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
   3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
   4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
   5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
   6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
   7. Furnish wire on spools.

2.8 RACEWAYS

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

2.9 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:
   1. Self-adhesive label bearing unique identification.
      a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
   2. Letter size shall be as follows:
      a. Enclosures: Minimum of 0.5 inch high.
      b. Electrical Power Devices: Minimum of 0.25 inch high.
      c. Instruments: Minimum of 0.25 inch high.
      d. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
   3. Legend shall consist of white lettering on black background.
   4. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
   5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

B. Raceway and Boxes:
   1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

D. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

E. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

F. Laminated Acrylic or Melamine Plastic Signs:
   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. Brady Corporation.
      b. Carlton Industries, LP.
      c. emedco.
      d. Marking Services, Inc.

2. Engraved legend.
3. Thickness:
    a. For signs up to 20 sq. in., minimum 1/16 inch thick.
    b. Engraved legend with black letters on white face.
    c. Self-adhesive.
    d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

G. Equipment Warning Labels:
1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inchbeyond white border.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for products to verify actual locations of connections before installation.
1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring and raceways.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Fastening Hardware:
1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

H. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

I. Corrosive Environments:
1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:
a. Process exhaust-air streams.
2. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:
1. Electrical power devices.
2. Relays.
3. Accessories.
4. Instruments.
5. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:
1. For NEMA 250, Type 1 Enclosures: Use galvanized-steel strut and hardware.
2. For NEMA 250, Type 4 and Type 4X Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top of adjacent enclosures.

D. Install floor-mounted enclosures located on concrete housekeeping pads. Attach enclosure legs using galvanized-steel anchors.

3.4 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to ATC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to ATC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

D. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.5 IDENTIFICATION

A. Install self-adhesive labels with unique identification on face for each of the following:
   1. Device enclosure.
   2. Electrical power device.

B. Install laminated acrylic or melamine sign with unique identification on face of ATC controller enclosures.

C. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with the conductor designation.

D. Install unique instrument identification on face of each instrument connected to a ATC controller.

E. Install unique identification on face of each control damper and valve actuator connected to a ATC controller.

F. Warning Labels and Signs:
   1. Shall be permanently attached to equipment that can be automatically started by ATC control system.
   2. Shall be located in highly visible location near power service entry points.

3.6 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Wiring to be done under this Section shall consist of, but not be limited to, the following:
   1. Between ATC panels and MCCs.
   2. Between ATC panels and all sensors and switches.
   3. Between ATC panels and all operators and controllers.
   4. Between ATC panels and control panels on equipment provided by the HVAC contractor.
   5. Between alarm devices provided by the other trades and ATC panels.
   6. Power wiring from ATC panels to switches and sensors.

B. Refer to Electrical Drawings for details of wiring at motor control panels. Provide interconnecting wiring to start and stop motors.

C. Comply with NECA 1.

D. Wire and Cable Installation:
1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
   a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Terminate wiring in a junction box.
   a. Clamp cable over jacket in junction box.
   b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
4. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
5. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
6. Use shielded cable to transmitters.
7. Use shielded cable to temperature sensors.
8. Perform continuity and meager testing on wire and cable after installation.

E. Conduit Installation:
1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Testing:
1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by ATC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum,

final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.

5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain ATC system.

B. Extent of Training:
   1. Base extent of training on scope and complexity of ATC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
   2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
   3. Minimum Training Requirements:
      a. Provide not less than one days of training total.
      b. All training shall occur before end of warranty period.

END OF SECTION 230923

SECTION 231123 - FACILITY NATURAL-GAS PIPING

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. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Manual gas shutoff valves.
5. Pressure regulators.
6. Service meters.
7. Dielectric fittings.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following:
1. Piping.
2. Piping specialties.
3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
4. Pressure regulators. Indicate pressure ratings and capacities.
5. Dielectric fittings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:
1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   a. Material Group: 1.1.
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
   e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.3 PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40 or 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
   4. CWP Rating: 125 psig.

B. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 MANUAL GAS SHUTOFF VALVES

A. See "Manual Gas Shutoff Valve Schedule" for where each valve type is applied in various services.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. A.Y. McDonald Mfg. Co.
      b. Apollo Flow Controls; Conbraco Industries, Inc.
      c. BrassCraft Manufacturing Co.; a Masco company.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
   4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
   1. Body: Bronze, complying with ASTM B 584.
   2. Ball: Chrome-plated brass.
   3. Stem: Bronze; blowout proof.

4. Seats: Reinforced TFE; blowout proof.
5. Packing: Separate packnut with adjustable-stem packing threaded ends.
6. Ends: Threaded, flared, or socket.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket.
7. CWP Rating: 600 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.
1. Body: Bronze, complying with ASTM B 584.
2. Plug: Bronze.
3. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Operator: Square head or lug type with tamperproof feature where indicated.
5. Pressure Class: 125 psig.
6. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
7. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.
1. Body: Cast iron, complying with ASTM A 126, Class B.
2. Plug: Bronze or nickel-plated cast iron.
3. Seat: Coated with thermoplastic.
4. Stem Seal: Compatible with natural gas.
5. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Pressure Class: 125 psig.
8. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 PRESSURE REGULATORS

A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.
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. Actaris.
b. American Meter Company.
c. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
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. Eaton.
b. Harper Wyman Co.
c. Maxitrol Company.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Description:
a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.

c. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.2 PREPARATION

A. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

B. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install fittings for changes in direction and branch connections.

C. Install pressure gage downstream from each service regulator.

3.4 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Locate valves for easy access.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Verify final equipment locations for roughing-in.

I. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

J. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

K. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

M. Connect branch piping from top or side of horizontal piping.

N. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

O. Do not use natural-gas piping as grounding electrode.

P. Install strainer on inlet of each line-pressure regulator.

Q. Install pressure gage downstream from each line regulator.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with maximum spacing and minimum rod sizes according to the International Fuel Gas Code.

3.8 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 PAINTING

A. Paint exposed, exterior metal piping, valves, service regulators and piping specialties, except components, with factory-applied paint or protective coating.
1. Alkyd System: MPI EXT 5.1D.
a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: Gray.

B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Natural-gas piping NPS 2 and smaller shall be the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.

A. Natural-gas piping larger than NPS 2 shall be the following:
   1. Steel pipe with wrought-steel fittings and welded joints.

3.12 PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

A. Natural-gas piping larger than NPS 2 shall be the following:
   1. Steel pipe with steel welding fittings and welded joints.

3.13 MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller shall be one of the following:
   1. One-piece, bronze ball valve with bronze trim.
   2. Two-piece, full-port, bronze ball valves with bronze trim.
   3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Two-piece, full-port, bronze ball valves with bronze trim.
   2. Bronze plug valve.
   3. Cast-iron, nonlubricated plug valve.

END OF SECTION 231123

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SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   3. Sheet metal materials.
   4. Sealants and gaskets.
   5. Hangers and supports.

B. Related Sections:
   1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Section 233116 "Nonmetal Ducts" for thermoset fiber-reinforced plastic ducts.
   3. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Sealants and gaskets.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top and bottom of ducts.
   5. Dimensions of all duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

B. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of aluminum unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Construct ducts of aluminum unless otherwise indicated.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ductmate Industries, Inc.
   b. Elgen Manufacturing.
   c. McGill AirFlow LLC.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
   8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

D. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Corrosive Environments: 316 stainless steel.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables: Stainless steel complying with ASTM A 492.

D. Steel Cable End Connections: stainless steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: stainless steel sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: stainless-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

K. Elbows: Use long-radius elbows wherever they fit.
   1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
   2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

L. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

D. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.
1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Air-handling unit internal surfaces and components including mixing box, filters and filter sections.
3. Supply-air ducts, dampers, actuators, and turning vanes.
4. Dedicated ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Provide drainage and cleanup for wash-down procedures.
5. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.7 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with aluminum sheet except as otherwise indicated and as follows:

B. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

C. Supply Ducts:
1. Pressure Class: Positive 2-inch wg.
a. Minimum SMACNA Seal Class: A.
b. SMACNA Leakage Class for Round and Flat Oval: **2**.

D. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Pressure Class: Positive 2-inch wg.
a. Minimum SMACNA Seal Class: A.

E. Intermediate Reinforcement:
1. Aluminum Ducts: Aluminum.

F. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-

1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees."
a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233116 – NON-METAL DUCTS

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. Thermoset FRP ducts and fittings.

B. Related Sections:
   1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for nonmetal ducts.
   2. Section 233113 "Metal Ducts" for single- and double-wall, rectangular and round ducts.
   3. Section 233300 "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including duct closure, reinforcements, and hangers and supports, shall comply with SMACNA's "Fibrous Glass Duct Construction Standards" and performance requirements and design criteria indicated.
   1. Static-Pressure Classes:
      a. Exhaust Ducts (Negative Pressure): 2-inch wg.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Thermoset FRP duct materials.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Duct layout indicating sizes and pressure classes.
   3. Elevation of top of ducts.
   4. Dimensions of main duct runs from building grid lines.
   5. Fittings.
   6. Reinforcement and spacing.
   7. Seam and joint construction.
   8. Penetrations through fire-rated and other partitions.
   9. Equipment installation based on equipment being used on Project.

10. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Structural members to which duct will be attached.

PART 2 - PRODUCTS

2.1 THERMOSET FRP DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Perry Fiberglass Products, Inc.
   2. Spunstrand
   3. Monoxivent
   4. Or equal

B. Duct and Fittings:
   1. Thermoset FRP Resin: Manufacture duct with resin that complies with UL 181, Class 1, maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL according to ASTM E 84.
   2. Inner Liner: FSK liner rated by an NRTL to comply with UL 181, Class 1.
   3. Round Duct: ASTM D 2996, Type I, Grade 2, Class E, filament-wound duct, minimum 0.125-inch wall thickness, with tapered bell and spigot ends for adhesive joints, or plain ends with couplings.
   4. Round Fittings: Compression or spray-up/contact, molded of same material, pressure class, and joining method as duct.
   5. Rectangular Fittings: Minimum 0.125-inch- thick flat sheet with fiberglass roving and resin-reinforced joints and seams.

C. Joining Materials: Roving and polyester resin.

D. Fabrication:
   1. Fabricate joints, seams, transitions, reinforcement, elbows, branch connections, and access doors and panels according to SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."
   2. Fabricate 90-degree rectangular mitered elbows to include turning vanes, 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

E. Drains: Formed drain pockets with a minimum of NPS 1 threaded pipe connections.

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Corrosive Environments: 316 stainless steel.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables: ASTM A 492, stainless steel with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Duct Attachments: stainless steel sheet metal screws, blind rivets, or self-tapping metal screws.

E. Trapeze and Riser Supports: 316 stainless steel.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts with fewest possible joints.

B. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

C. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

D. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

E. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges. Overlap openings on four sides by at least 1-1/2 inches.

F. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

G. Protect duct interiors from the moisture, construction debris and dust, and other foreign materials.

H. Install thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual."

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports for thermoset FRP ducts and fittings to comply with SMACNA's "Thermoset FRP Duct Construction Manual," Chapter 7, "Requirements."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch duct as recommended by duct manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

C. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   3. Supply-air ducts, dampers, actuators, and turning vanes.
   4. Dedicated exhaust and ventilation components and makeup air systems.

D. Mechanical Cleaning Methodology:
   1. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
   2. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.

3. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.5 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.6 DUCT SCHEDULE

A. Exhaust Ducts and Fittings:
   1. Thermoset FRP Round Ducts and Fittings.

END OF SECTION 233116

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SECTION 233300 - AIR DUCT ACCESSORIES

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. Manual volume dampers.
   2. Control dampers.
   3. Turning vanes.
   4. Duct-mounted access doors.
   5. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For duct accessories.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.
      d. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

B. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Aluminum, Manual Volume Dampers:
   1. Standard leakage rating.
   2. Suitable for horizontal or vertical applications.
   3. Frames: Hat-shaped, 0.10-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
      e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
   5. Blade Axles: Stainless steel.
   6. Bearings:
      a. Stainless-steel sleeve.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   7. Tie Bars and Brackets: Aluminum.

2.4 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Nailor Industries Inc.
   3. Ruskin Company.

B. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
   1. Hat or U shaped.
   2. 0.094-inch- thick, galvanized sheet steel.
   3. Interlocking, gusseted corners.

D. Blades:
1. Multiple blade with maximum blade width of 6 inches.
2. Parallel or Opposed-blade design.
3. Aluminum.
4. 0.064 inch thick single skin.
5. Blade Edging: Closed-cell neoprene or PVC.

E. Blade Axles: 1/2-inch- diameter; galvanized steel or stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
1. Molded synthetic or Stainless-steel sleeve.

2.5 TURNING VANES

A. 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:
1. Aero-Dyne Sound Control Co.
2. Ductmate Industries, Inc.
3. METALAIRE, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall.

2.6 DUCT-MOUNTED ACCESS DOORS

A. 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:
1. Aire Technologies.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Vision panel.
d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.7 FLEXIBLE CONNECTORS

A. 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:
1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd.
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. Downstream from manual volume dampers and control dampers.
2. Upstream from turning vanes.
3. Control devices requiring inspection.
4. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Install flexible connectors to connect ducts to equipment.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300

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SECTION 233423 - HVAC POWER VENTILATORS

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. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include 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 thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Belts: One set(s) for each belt-driven unit.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705.

1.8 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hartzell Fan Incorporated.
   2. Aerovent
   3. MK Plastics

B. Housing: Removable, fiberglass

C. Fan Wheels: fiberglass

D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.

E. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing.
   2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Overall Height: 24 inches.

G. Capacities and Characteristics:
1. Refer to Drawings.

2.2 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

SECTION 233713.23 - REGISTERS AND GRILLES

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. Fixed face registers and grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

A. Fixed Face Register:
   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. Nailor Industries Inc.
      b. Price Industries.
      c. Titus.
   2. Material: Aluminum.
   3. Finish: Baked enamel, white.
   4. Face Blade Arrangement: Horizontal spaced 3/4 inch or 1/2 inch apart.
   5. Frame: 1-1/4 inches wide.
   6. Mounting: Countersunk screw.
   7. Damper Type: Adjustable opposed blade.

2.2 GRILLES

A. Fixed Face Grille:
   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. Nailor Industries Inc.

b. Price Industries.
c. Titus.

2. Material: Aluminum.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal; spaced 3/4 inch or 1/2 inch apart.
5. Frame: 1-1/4 inches wide.
6. Mounting: Countersunk screw.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.

C. Install registers and grilles with airtight connections to ducts.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 237423.16 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

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.

B. Related Requirements:
1. Section 230513 “Common Motor Requirements for HVAC Equipment”
2. Section 230593 "Testing, Adjusting, and Balancing for HVAC."
3. Section 231123 "Facility Natural-Gas Piping."
4. Section 233113 "Metal Ducts."
5. Section 233300 "Air Duct Accessories."

1.2 SUMMARY

A. Section includes indirect-fired makeup-air units.

1.3 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, rooftop units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and configuration of outdoor, indirect-fired makeup-air unit.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type and configuration of outdoor, indirect-fired heating and ventilating unit.
1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
4. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For indirect-fired makeup-air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: Three set(s) for each unit.
   2. Fan Belts: One set(s) for each unit.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indirect-fired heating and ventilating units that fail in materials or workmanship within standard warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. 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:
   1. Greenheck Fan Corporation.
   2. REZNOR, a brand of Nortek Global HVAC.
   3. Titan Air.
   4. Trane Inc.

2.2 SYSTEM DESCRIPTION

A. Factory-assembled, prewired, self-contained unit consisting of cabinet, supply fan, controls, filters, and indirect-fired gas burner to be installed exterior to the building.

2.3 PERFORMANCE REQUIREMENTS

A. ANSI Z83.8.

2.4 UNIT CASINGS

A. General Fabrication Requirements for Casings:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
   2. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.

B. Configuration: Horizontal unit with bottom discharge for roof-mounting installation.

C. Cabinet: Aluminized- or galvanized-steel panels, formed to ensure rigidity and supported by galvanized-steel channels or structural channel supports with lifting lugs.

D. Outer Casing: steel with over-corrosion-resistant-treated surface in color to match fan section.

E. Inner Casing:
   1. Burner Section Inner Casing: 0.0299-inch- thick steel.
   2. Internal Insulation: Fibrous-glass duct lining, neoprene coated, comply with ASTM C 1071, Type II.

F. Corrosion-Resistant Coating: Apply a corrosion-resistant coating capable of withstanding a minimum 4,000-hour salt-spray test according to ASTM B 117.

G. Casing Insulation and Adhesive:
   1. Materials: ASTM C 1071, Type I or Type II.
   2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the heating-coil section.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive, mechanical, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.

H. Inspection and Access Panels and Access Doors:
   1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
   2. Inspection and Access Panels:
      a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
      b. Gasket: Neoprene, applied around entire perimeters of panel frames.
      c. Size: Large enough to allow inspection and maintenance of unit's internal components.
   3. Service Light: 100-W vaporproof fixture with switched junction box located adjacent to door.

2.5 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.6 OUTDOOR-AIR INTAKE HOOD

A. Type: Manufacturer's standard hood.

B. Materials: Match cabinet.

C. Filter: Aluminum, 1 inch cleanable.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.7 ROOF CURBS

A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
   1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
      a. Materials: ASTM C 1071, Type I or Type II.
      b. Thickness: 1-1/2 inches.
   2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
      a. Liner Adhesive: Comply with ASTM C 916, Type I.
      b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
      c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

B. Curb Height: per schedule on Drawings.

2.8 SUPPLY-AIR FAN

A. Fan Type: Centrifugal, rated according to AMCA 210; statically and dynamically balanced, galvanized steel; mounted on solid-steel shaft with heavy-duty bearings.

B. Drive:
   1. V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly.

C. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with elastomeric or spring isolators.

D. Fan-Shaft Lubrication Lines: Extended to a location outside the casing.

2.9 AIR FILTERS

A. Per schedule on Drawings.

2.10 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.

B. Damper Operators: Comply with requirements in Section 233300 "Air Duct Accessories."

2.11 INDIRECT-FIRED GAS BURNER

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47, "Gas-Fired Central Furnaces," and with NFPA 54, "National Fuel Gas Code."
   1. CSA Approval: Designed and certified by and bearing label of CSA.
   2. Burners: Stainless steel.
      a. Gas Control Valve: Modulating.
      b. Rated maximum turndown ratio of 4 to 1.
      c. Fuel: Natural gas.
      d. Minimum Combustion Efficiency: 80 percent.
      e. Ignition: Electronically controlled electric spark with flame sensor.

B. Venting: Gravity vented.

C. Combustion-Air Intake: Separate combustion-air intake and vent terminal assembly.

D. Heat Exchanger: Stainless steel.

E. Safety Controls:
   1. Vent Flow Verification: Differential pressure switch to verify open vent or Flame rollout switch.
   2. Control Transformer: 24-V ac.
   3. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
   4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
   5. Gas Manifold: Safety switches and controls complying with ANSI standards.
   6. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
   7. Automatic-Reset, High-Limit Control Device: Thermal switch or fuse stops burner and closes main gas valve if high-limit temperature is exceeded.
   8. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.12 UNIT CONTROL PANEL

A. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.

B. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:
   1. On-off switch.
   2. Supply-fan operation indicating light.
   3. Heating operation indicating light.
   4. Thermostat.
   5. Damper position potentiometer.

6. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
7. Safety-lockout indicating light.
8. Enclosure: NEMA 250, Type 4X.

2.13 CONTROLS

A. Control Devices:
   1. Remote Override Thermostat Adjustable.

B. Fan Control: Interlock fan to start with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.

C. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

D. Temperature Control:
   1. Operates gas valve to maintain space temperature with wall-mounted, field-wired sensor with temperature adjustment.
   2. Burner Control: Two or four steps of control using one or two burner sections in series.
   3. Burner Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

2.14 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency.
   1. Enclosure: Totally enclosed, fan cooled.

2.15 CAPACITIES AND CHARACTERISTICS

A. Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine 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 piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.

D. Examine roofs for suitable conditions where units will be installed.

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

3.2 INSTALLATION

A. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."

B. Install controls and equipment shipped by manufacturer for field installation with indirect-fired heating and ventilating units.

C. Roof Curb: Install units on curbs and coordinate roof penetrations and flashing with roof construction. Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

B. Duct Connections: Connect ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Install control and electrical power wiring to field-mounted control devices.

F. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Install nameplate according to Section 230553 “Identification for HVAC Piping and Equipment.”

3.4 STARTUP SERVICE

A. Perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for visible damage to burner combustion chamber.
   2. Inspect casing insulation for integrity, moisture content, and adhesion.
   3. Verify that shipping, blocking, and bracing are removed.

4. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
8. Verify that labels are clearly visible.
9. Verify that filters are installed.
10. Purge gas line.
11. Inspect and adjust vibration isolators.
12. Verify that outdoor-air dampers open and close.
13. Verify bearing lubrication.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.
1. Complete any manufacturer startup sheets.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:
    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
    d. Measure flue-gas temperature at furnace discharge.
5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke.
8. Inspect controls for correct sequencing of heating, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
11. Measure and record motor electrical values for voltage and amperage.
12. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:
    a. High-limit heat.
    b. Alarms.
13. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
14. Verify drain-pan performance.
15. Verify outdoor-air damper operation.

3.5 CLEANING

A. After completing system installation testing, adjusting, and balancing and after completing startup service:
1. Clean units internally to remove foreign material, construction dirt and dust.

2. Clean fan wheels, cabinets, dampers, coils, and filter housings.
3. Install new, clean filters.

3.6 ADJUSTING

A. Adjust initial temperature set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heating and ventilating units.

END OF SECTION 237423.16

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SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

1.6 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a unit of United Technologies Corp.
   2. Mitsubishi Electric & Electronics USA, Inc.
   3. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:
   1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Engineer, and discharge drain pans with drain connection.
   2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
   3. Fan: Direct drive, centrifugal.
   4. Fan Motors:
      a. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   5. Condensate Drain Pans:
      a. Fabricated with one or two percent slope in at least two planes to collect condensate from cooling coils, and to direct water toward drain connection.
         1) Length: Extend drain pan downstream from leaving face.
         2) Depth: A minimum of 1 inch deep.
      b. Single-wall, galvanized or stainless-steel sheet.
      c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end or both ends of pan.

2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by Engineer, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Scroll.
      b. Refrigerant: R-410A.

c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:
1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

2.5 CAPACITIES AND CHARACTERISTICS

A. Refer to schedules on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports or curbs. Anchor units to supports per manufacturer’s requirements.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238239.16 - PROPELLER UNIT HEATERS

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 propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
   6. Indicate location and arrangement of integral controls.
   7. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane.
   2. Indeeco.
   3. Qmark.

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 HOUSINGS

A. 16-gauge 304 stainless steel.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded and sealed in steel or corrosion-resistant metallic sheath. Element ends shall be enclosed in terminal box.
   1. Circuit Protection: overcurrent protection and limit controls for high-temperature protection of heaters.

2.5 FAN AND MOTOR

A. Fan: Propeller type with wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Control Devices:
   1. Unit-mounted, fan-speed switch.

2. Unit-mounted thermostat.

2.7 CAPACITIES AND CHARACTERISTICS

A. Refer to Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239.16

SECTION 260513 - MEDIUM-VOLTAGE CABLES

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 cables and related cable splices, terminations, and accessories for medium-voltage (2001 to 35,000 V) electrical distribution systems.

1.3 DEFINITIONS

A. Jacket: A continuous nonmetallic outer covering for conductors or cables.

B. NETA ATS: Acceptance Testing Specification.

C. Sheath: A continuous metallic covering for conductors or cables.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cable. Include splices and terminations for cables and cable accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Indicate location of each cable, splice, and termination.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type of cable and accessory.

D. Design Data: Cable pulling calculations, including conduit size and fill percentage, pulling tensions, cable sidewall pressure, jam probability, voltage drop, and ground wire sizing for each cable.

E. Source quality-control reports.

F. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than five days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2 and NFPA 70.

C. Source Limitations: Obtain cables and accessories from single source from single manufacturer.

2.2 CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Cable; General Cable Corporation.
   2. Okonite Company (The).
   3. Prysmian Power Cables and Systems USA, LLC.
   4. Southwire Company.

B. Cable Type: Type MV 105.

C. Conductor Insulation: Ethylene-propylene rubber.
   1. Voltage Rating: 5 kV.
   2. Insulation Thickness: 133 percent insulation level.

D. Conductor: Copper.

E. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.

F. Conductor Stranding: Concentric lay, Class B.

G. Shielding: Copper tape, helically applied over semiconducting insulation shield.

H. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

I. Cable Sheath: Interlocked galvanized steel applied over cable.

J. Cable Jacket: Sunlight-resistant PVC.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
2. MP Husky USA Cable Tray & Cable Bus.
3. Raychem; a brand of nVent.
4. TE Connectivity Ltd.
5. Thomas & Betts Corporation; A Member of the ABB Group.

B. Copper-Conductor Connectors: Copper barrel crimped connectors.

2.4 SOLID TERMINATIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. 3M.
2. MP Husky USA Cable Tray & Cable Bus.
3. Raychem; a brand of nVent.
4. TE Connectivity Ltd.
5. Thomas & Betts Corporation; A Member of the ABB Group.

B. Multiconductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
1. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.

C. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   2. MP Husky USA Cable Tray & Cable Bus.
   3. Raychem; a brand of nVent.
   4. TE Connectivity Ltd.

C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

D. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Break Cable Terminators: Elbow-type unit with 200-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

F. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders and carrying case.
   4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

G. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.6 MEDIUM-VOLTAGE TAPES

A. Description: Electrical grade, insulating tape rated for medium voltage application.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   2. MP Husky USA Cable Tray & Cable Bus.
   3. Raychem; a brand of nVent.
   4. TE Connectivity Ltd.

C. Ethylene/propylene rubber-based, 30-mil splicing tape, rated for 130 deg C operation. Minimum 3/4 inch wide.

2.7 ARC-PROOFING MATERIALS

A. Description: Fire retardant, providing arc flash protection.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M.
   2. MP Husky USA Cable Tray & Cable Bus.
   3. Raychem; a brand of nVent.
   4. TE Connectivity Ltd.

C. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

D. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.

E. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

2.8 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
   1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
   2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

C. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that does not deteriorate conductor or insulation.

2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Install "buried-cable" warning tape 12 inches above cables.

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.

H. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.

I. Install terminations at ends of conductors, and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:
1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-Through Accessory: At each terminal junction, with one on each terminal.
3. Standoff Insulator: At each terminal junction, with one on each terminal.
4. Clean cable sheath.
5. Wrap metallic cable components with 10-mil pipe-wrapping tape.
6. Smooth surface contours with electrical insulation putty.
7. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
8. Band arc-proofing tape with two layers of 1-inch- wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.

K. Seal around cables passing through fire-rated elements according to Section 078413 "Penetration Firestopping."

L. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

M. Identify cables according to Section 260553 "Identification for Electrical Systems." Identify phase and circuit number of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Medium-voltage cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 260513

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Copper building wire rated 600 V or less.
   2. Fire-alarm wire and cable.
   3. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
   1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.
   2. Section 271523 “Communications Optical Fiber Horizontal Cabling” for fiber optic cables.

1.3 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

B. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden Inc.
   2. General Cable Technologies Corporation.
   3. Okonite Company (The).
   4. Southwire Company.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:
   1. Type THHN and Type THWN-2: Comply with UL 83.
   2. Type XHHW-2: Comply with UL 44.

2.2 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. 3M Electrical Products.
   2. Ideal Industries, Inc.
   3. O-Z/Gedney; a brand of Emerson Industrial Automation.
   4. Service Wire Co.
   5. TE Connectivity Ltd.
   6. Thomas & Betts Corporation; A Member of the ABB Group.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: Two hole with standard barrels.
   3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

E. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
   1. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
   1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
   2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
   3. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Comply with requirements in Section 284621.11 “Addressable Fire-Alarm Systems” for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
   1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
   2. Perform each of the following visual and electrical tests:
      a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
      b. Test bolted connections for high resistance using one of the following:
         1) A low-resistance ohmmeter.
         2) Calibrated torque wrench.
         3) Thermographic survey.
      c. Inspect compression-applied connectors for correct cable match and indentation.
      d. Inspect for correct identification.
      e. Inspect cable jacket and condition.
      f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
      g. Continuity test on each conductor and cable.
      h. Uniform resistance of parallel conductors.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports to record the following:
   1. Procedures used.
   2. Results that comply with requirements.
   3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Low-voltage control cabling.
   2. Control-circuit conductors.
   3. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: Provide samples of proposed wire in 12 inch size, type of insulation and voltage stenciled on the jacket.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

C. RoHS compliant.

2.2 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.
   1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
   2. PVC insulation with 300 Volt, 105 degrees C rating.
   3. Shielded 100% aluminum/polyester foil with drain wire.
   4. PVC jacket with UL Subject 13, UL 1581 and manufacturers' identification.
   5. Flame Resistance: Comply with UL 1685.
   6. Max overall diameter: 0.273-inches.

2.3 CONTROL-CIRCUIT CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Encore Wire Corporation.
   2. General Cable; General Cable Corporation.
   3. Southwire Company.

B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

2.4 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.
   1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:
   1. Extend conduits 3 inches above finished floor.
   2. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with TIA-568-C Series of standards.
   2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
   3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
   4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
   5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
   6. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
   8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Installation of Control-Circuit Conductors:
1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-D recommendations for separating shielded cable from potential EMI sources including electrical power lines and equipment.
2. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.5 GROUNDING

A. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
   1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments and inspect cabling connections to confirm compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 260523

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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 grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Test wells.
   2. Ground rods.
   3. Ground rings.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:
         1) Test wells.
         2) Ground rods.
         3) Ground rings.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

A. 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:
   1. Burndy; Part of Hubbell Electrical Systems.
   2. Erico, Inc.
   3. O-Z/Gedney; a brand of Emerson Industrial Automation.
   4. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B3.
   2. Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B33.
   4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
   5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Ground Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

H. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

I. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

J. Straps: Solid copper, cast-bronze clamp. Rated for 600 A.

K. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one-piece clamp.

L. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

M. Water Pipe Clamps:
   1. Mechanical type, two pieces with zinc-plated bolts.
      a. Material: Tin-plated aluminum.
      b. Listed for direct burial.
   2. U-bolt type with malleable-iron clamp and copper ground connector.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

2.6 EXOTHERMIC WELDING

A. Exothermic welding shall be by CADWELD process, or equal. Molds and powder shall be furnished by the same manufacturer and sized and selected per manufacturer's instructions for specific combination of conductors and connected items.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install barecopper conductor, No. 2/0 AWG minimum.
   1. Bury at least 30 inches below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Ground Bus: Install in electrical equipment rooms.
   1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

F. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.4 INSTALLATION

A. Grounding Electrode Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
1. Where conductors pass through floor slabs, walls, etc., they shall be installed in conduit or sleeved.
2. Conductors subject to mechanical damage shall be protected by non-ferrous conduit to avoid a choke effect for fault currents.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. Rods shall be installed vertically and not allowed to be deformed or driven at an angle. Where driving is difficult or where rock is encountered, Contractor shall use purpose-designed drilling equipment, install the rod into the drilled hole and backfill around rod using ground enhancement material (GEM) mixed with water to form a slurry in accordance with the Manufacturer's instructions.
4. Test Wells: Ground rod test wells shall be complete with cast iron riser ring and traffic cover marked "GROUND ROD". Boxes and covers shall be suitable for H-20 wheel loading.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Installbonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart or as shown on the Contract Drawings.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.
3. Lay all underground conductors slack, and where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate in accordance with NEC Article 250.52 and connect to grounding electrode system.

J. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
4. Pad-Mounted Equipment: 5 ohms.
5. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Steel slotted support systems.
   2. Aluminum slotted support systems.
   3. Nonmetallic slotted support systems.
   4. Conduit and cable support devices.
   5. Support for conductors in vertical conduit.
   6. Structural steel for fabricated supports and restraints.
   7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
   8. Fabricated metal equipment support assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
      a. Slotted support systems, hardware, and accessories.
      b. Clamps.
      c. Hangers.
      d. Sockets.
      e. Eye nuts.
      f. Fasteners.
      g. Anchors.
      h. Saddles.
      i. Brackets.
   2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc. shall be galvanized iron or steel.

B. PVC coated steel channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations. Fiberglass channel shall be resistant to the chemicals present in the area in which it is used.

C. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.

D. Conduit Supports:
   1. Trapezes:
      a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.
      b. PVC coated steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals resent in the area in which it is used.
   2. Flush Mounted Supports:
      a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.
      b. PVC coated steel channels, struts or fiberglass channels, struts with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels, struts shall be resistant to the chemicals present in the area in which it is used.
   3. Conduit Racks:
      a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.
      b. PVC coated steel conduit racks or fiberglass conduit racks with stainless, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations. Fiberglass channels shall be resistant to the chemicals present in the area in which it is used.
   4. Conduit Hangers:
      a. In dry indoor areas, conduit clamps, rods, beam clamps, bracing, accessories and components shall be galvanized steel.
      b. Stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

E. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; a part of Atkore International.
      b. Thomas & Betts Corporation; A Member of the ABB Group.
      c. Unistrut; Part of Atkore International.
   2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   3. Material for Channel, Fittings, and Accessories: Galvanized steel, PVC Coated Steel.
   4. Channel Width: Selected for applicable load criteria
   5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

F. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

G. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

H. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

I. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) B-line, an Eaton business.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti, Inc.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
   3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A F3125/F3125M, Grade A325 (Grade A325M).
   5. Toggle Bolts: All-steel springhead type.
   6. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA 101

B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   6. To Light Steel: Sheet metal screws.
   7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Boxes, enclosures, and cabinets.

B. Related Requirements:
   1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Samples: For nonmetallic wireways and for each color and texture specified, 12 inches long.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
   1. Structural members in paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.

B. Underground More than 5 feet outside Foundation Wall: Provide nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.

C. Underground Within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.

D. In or Under Slab on Grade: nonmetallic conduit. Provide cast or nonmetallic metal boxes.

E. Outdoor Locations, Above Grade: Provide PVC-coated rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.

F. In Slab Above Grade: Provide rigid steel conduit. Provide cast boxes.

G. Wet and Damp Locations: Provide PVC-coated rigid steel conduit. Provide cast metal or nonmetallic outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.

H. Concealed Dry Locations: Provide PVC-coated rigid steel conduit. Provide sheet-metal boxes. Provide hinged enclosure for large pull boxes.

I. Exposed Dry Locations: Provide rigid steel conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

J. Corrosive Locations: Provide PVC Coated Rigid Steel Conduit. Provide PVC coated cast metal boxes.

2.2 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; a part of Atkore International.
      b. Perma-Cote.
      c. Plasti-Bond.
      d. Southwire Company.
      e. Thomas & Betts Corporation; A Member of the ABB Group.
   2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   3. GRC: Comply with ANSI C80.1 and UL 6.
   4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch, minimum.

5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
6. SSC: Comply with ASTM A312 and UL 6A. Type 316.

B. Metal Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Allied Tube & Conduit; a part of Atkore International.
b. O-Z/Gedney; a brand of Emerson Industrial Automation.
c. Southwire Company.
d. Thomas & Betts Corporation; A Member of the ABB Group.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.3 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Champion Fiberglass, Inc.
b. RACO; Hubbell.
c. Thomas & Betts Corporation; A Member of the ABB Group.
2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. LFNC: Comply with UL 1660.

B. Nonmetallic Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Champion Fiberglass, Inc.
b. RACO; Hubbell.
c. Thomas & Betts Corporation; A Member of the ABB Group.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.

3. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.
   a. Fittings for LFNC: Comply with UL 514B.
4. Solvents and Adhesives: As recommended by conduit manufacturer.

C. Conduit Supports: Provide the following types of conduit supports.
1. Trapezes:
   a. Provide galvanized steel beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components, in dry indoor areas.
   b. in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations use PVC coated steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components. Provide fiberglass channels resistant to the chemicals present in the area in which it is used.
2. Flush Mounted Supports:
   a. In dry indoor areas, channels, struts, accessories and components shall be galvanized steel.
   b. In areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations use PVC coated steel channels, struts or fiberglass channels, struts with stainless, accessories and components. Provide fiberglass channels, struts resistant to the chemicals present in the area in which it is used.
3. Conduit Racks:
   a. Provide galvanized steel, conduit racks, accessories and components in dry indoor areas.
   b. In areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations use PVC coated steel conduit racks or fiberglass conduit racks with stainless, accessories and components. Provide fiberglass channels resistant to the chemicals present in the area in which it is used.
4. Conduit Hangers:
   a. Provide galvanized steel conduit clamps, rods, beam clamps, bracing, accessories and components, in dry indoor areas.
   b. In areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations use stainless steel conduit clamps, rods, beam clamps, bracing, accessories and components.

2.4 MISCELLANEOUS FITTINGS

A. Flexible Couplings:
1. Manufacturers: Provide products by one of the following:
   a. “Type ECGJH,” by the Crouse-Hinds Co.
   b. Appleton Electric Co.
   c. Killark Electric Manufacturing Co.
   d. Or equal.

B. Conduit Hubs:
1. Manufacturers: Provide products by one of the following:
   a. Myers Electric Products, Inc.
   b. Or equal.

C. Conduit Wall Seals For New Concrete Walls Below Grade:
1. Products: Provide one of the following:

a. O.Z./Gedney Co., Type WSK; Linkseal.
b. Spring City Electrical Manufacturing Co., Type WDP.
c. Or equal.

D. Conduit Wall Seals For Cored Holes:
1. Products: Provide one of the following:
a. Type CSMC as manufactured by the O.Z./Gedney Co.
b. Or equal.

E. Conduit Wall And Floor Seals For Sleeved Openings:
1. Products: Provide one of the following:
a. Type CSMI as manufactured by the O.Z./Gedney Co.
b. Or equal.

F. Combination Expansion-Deflection Fittings Embedded In Concrete:
1. Products: Provide one of the following:
a. Type XD as manufactured by the Crouse-Hinds Co.
b. Type DX as manufactured by O.Z./Gedney Co.
c. Type DF as manufactured by Appleton Electric Co.
d. Or equal.

G. Combination Expansion-Deflection Fittings Installed Exposed:
1. Products: Provide one of the following:
a. Type XD as manufactured by Crouse-Hinds Co.
b. Type DX as manufactured by O.Z. Gedney Co.
c. Type DF as manufactured by Appleton Electric Co.
d. Or equal.

H. Conduit Sealing Bushings:
1. Products: Provide one of the following:
a. O.Z./Gedney, Type CSB.
b. Or equal.

I. Grounding Bushings: Malleable iron with integral insulated throat rated for 300 degrees F, with solderless lugs.
1. Products: Provide one of the following:
a. Crouse Hinds/Cooper, Series HGLL.
b. Appleton, Series GIB.
c. O.Z./Gedney, Type HBLG.
d. Or equal.

J. Multi-Outlet Assembly:
1. Provide assembly enclosures consisting of two piece, all steel or anodized aluminum raceways which allow for field installation of wiring and standard receptacles as indicated on the Drawings.
2. Multi Outlet Assemblies: UL Listed as a Multi-outlet assembly.
3. Raceway Bases And Removable Covers: 0.040 inch steel, minimum of 2-1/8 inch high by 1-5/8 inch deep. Entrance fittings sized for 3/4 inch conduit.
4. Provide all raceways with all fittings, couplings, etc, for the complete installation of a finished system.
5. Device Covers:

a. Basis of Design: Provide “1702 Series,” by Walker, or equal by one of the following:
   1) Isoduct.
   2) Wiremold.

6. Basis Of Design For The Multi-Outlet Assembly: Provide “1700 Series,” by Walker, or equal by one of the following:
   a. Isoduct.
   b. Wiremold.

2.5 HARDWARE

A. Conduit Mounting Equipment:
   1. In dry indoor areas, provide hangers, rods, backplates, beam clamps, channel, etc. fabricated from galvanized iron or steel.
   2. In areas indicated "WET" or "CORROSIVE" on the Drawings and in outdoor locations use PVC coated steel channel with stainless steel hardware. Provide fiberglass channel resistant to the chemicals present in the area in which it is used.

B. Furnish all supports, brackets, conduit sleeves, racks and bracing required. Provide boxes and hardware fabricated from galvanized zinc plated steel, except provide stainless steel in areas indicated as "WET" or "CORROSIVE" on the Drawings.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Crouse-Hinds, an Eaton business.
   2. Hoffman; a brand of nVent.
   3. Hubbell Incorporated.
   4. O-Z/Gedney; a brand of Emerson Industrial Automation.
   5. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

I. Gangable boxes are prohibited.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Fiberglass.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
   1. NEMA 250, Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: PVC-Coated GRC.
   2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
   3. Underground Conduit: RNC, Type EPC-40-PVC,for power and control wiring. GRC for signal wiring.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed: PVC-Coated GRC.
   2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   3. Damp or Wet Locations: PVC-Coated GRC.
   4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.

3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
5. Change from RNC, Type EPC-40-PVC to PVC-coated GRC before rising above floor.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

R. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where an underground service raceway enters a building or structure.
   3. Conduit extending from interior to exterior of building.
   4. Conduit extending into pressurized duct and equipment.
   5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   6. Where otherwise required by NFPA 70.

V. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

W. Expansion-Joint Fittings:
   1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
   2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
      a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of LFMC for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

Y. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Z. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

AA. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

BB. Locate boxes so that cover or plate will not span different building finishes.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Install conduit sealing and drain fittings on all conduits entering and leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are: rooms where chlorine, ammonia, and ozone are stored, generated or heated. A sealing compound installation schedule shall be presented to Engineer for approval. Sign off on each installation and present the compound installation schedule to the Engineer for final sign-off. Each fitting shall be legibly marked with red paint to indicate that the sealing compound has been installed.

FF. Use liquid-tight flexible metal conduit for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. The length of liquid-tight flexible metal conduit shall not exceed 36 inches when used for vibration isolation and shall not exceed 72 inches in length when attaching to luminaires. Non-metallic flexible conduit shall only be allowed for use with rigid PVC conduit systems.

GG. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

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. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
   2. Rigid nonmetallic duct.
   3. Duct accessories.
   4. Precast concrete handholes.
   5. Precast manholes.

1.3 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:
   1. Two or more ducts installed in parallel, with or without additional casing materials.
   2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include duct-bank materials, including spacers and miscellaneous components.
   2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Include accessories for manholes, handholes, boxes.
   4. Include underground-line warning tape.
   5. Include warning planks.

B. Shop Drawings:
   1. Precast or Factory-Fabricated Underground Structures:

a. Include plans, elevations, sections, details, attachments to other work, and accessories.
b. Include duct entry provisions, including locations and duct sizes.
c. Include reinforcement details.
d. Include frame and cover design and manhole chimneys.
e. Include ladder details.
f. Include grounding details.
g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
h. Include joint details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Buoyancy calculations.
3. Drawings and calculations shall be signed and sealed by a qualified professional engineer.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.8 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; a part of Atkore International.
      b. Carlon; a brand of Thomas & Betts Corporation.
      c. Underground Devices, Inc.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.2 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Christy Concrete Products.
   2. Oldcastle Precast, Inc.
   3. Utility Concrete Products, LLC.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering, "ELECTRIC", “MEDIUM VOLTAGE”, or “SIGNAL” as indicated for each service.

G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   1. Extension shall provide increased depth of 12 inches.
   2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.

I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Splayed location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

K. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.3 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Christy Concrete Products.
   2. Oldcastle Precast, Inc.
   3. Utility Concrete Products, LLC.

C. Comply with ASTM C 858.

D. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

E. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   1. Splayed location.
   2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
   3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
   4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
   5. Knockout panels shall be 1-1/2 to 2 inches thick.

F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Engineer.

C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

3.2 UNDERGROUND DUCT APPLICATION

A. Ducts installed in ductbanks shall be as specified in Section 260533 “Raceways and Boxes for Electrical Systems” and as indicated on the Drawings.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses".

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.4 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.
   1. Duct shall have maximum of two 90-degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
   2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
   3. Grout end bells into structure walls from both sides to provide watertight entrances.

G. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

H. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

I. Pulling Cord: Install 200-lbf- test nylon cord in empty ducts.

J. Concrete-Encased Ducts and Duct Bank:
   1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earthwork" for pipes less than 6 inches in nominal diameter.
   2. Width: Excavate trench 3 inches wider than duct on each side.

3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
6. Elbows: Use manufactured PVC-coated GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
    a. Couple RNC duct to PVC-coated GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased PVC-coated GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
7. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
8. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
9. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
10. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
11. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

K. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all

concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891 unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
   3. Install handholes with bottom below frost line, below grade.
   4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms,as required for installation and support of cables and conductors and as indicated.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
   2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.
   1. Sweep floor, removing dirt and debris.
   2. Remove foreign material.

END OF SECTION 260543

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:
   1. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

C. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.
      e. Proco Products, Inc.
   2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel.
   4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
   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. HOLDRITE; Reliance Worldwide Company.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
   1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
      a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
      b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
   2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
   4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

D. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

F. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Color and legend requirements for raceways, conductors, and warning labels and signs.
   2. Labels.
   3. Bands and tubes.
   4. Tapes and stencils.
   5. Tags.
   6. Signs.
   7. Cable ties.
   8. Paint for identification.
   9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
   1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage.

B. Color-Coding for Identification, 600 V or Less: Use colors listed below for conductors.
   1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White.
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray.
   4. Color for Equipment Grounds: Green.
   5. Colors for Isolated Grounds: Green with two or more yellow white stripes.

C. Raceways and Cables Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification and Source Nameplates:
   1. Black letters on a white field.
   2. Nameplates shall be engraved, laminated plastic, not less than 1/16-inch thick by ¾-inch by 2-1/2-inch with 3/16-inch high lettering.
   3. All electrical equipment furnished under Divisions 26, 27, 28 and all equipment control panels furnished under other Divisions shall include equipment identification nameplates. Equipment includes motor control centers, panelboards, transformers, disconnect switches, separately mounted motor controllers, transfer switches, control panels, named terminal cabinets, pullboxes, etc. The designation of the equipment shall correspond to the designation shown on the Drawings.

4. Equipment identified in the previous paragraph above shall also include a nameplate with the power source identified

G. Device Identification Labels:
1. Black letters on a white field.
2. Labels shall be self-adhesive type and machine generated with ¼-inch high letters.
3. All receptacles, wall switches, lighting fixtures, emergency lights, exit lights, instruments, etc. shall be identified with the panel and circuit to which it is connected.

2.3 LABELS

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Panduit Corp.

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Champion America.
b. Ideal Industries, Inc.
c. Panduit Corp.

B. Underground-Line Warning Tape:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Ideal Industries, Inc.
c. Marking Services, Inc.
2. Tape:
a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines by either conductive or inductive location techniques.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. Color and Printing:
a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c. Inscriptions for Orange-Colored Tapes: "OPTICAL FIBER CABLE".
4. Tag:

a. Pigmented polyolefin, bright colored, compounded for direct-burial service.
b. Width: 6 inches.
c. Thickness: 4 mils.
d. Weight: 18.5 lb/1000 sq. ft..
e. Tensile according to ASTM D882: 150 lbf and 2500 psi.

C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 TAGS

A. Metal Tags: Brass, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Carlton Industries, LP.
c. Marking Services, Inc.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Brady Corporation.
b. Carlton Industries, LP.
c. Panduit Corp.

2.6 CABLE TIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ideal Industries, Inc.
2. Marking Services, Inc.
3. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. "EMERGENCY POWER."
   2. "POWER."
   3. "UPS."

J. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

K. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

L. Metal Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

M. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

N. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.

O. Equipment Nameplates:
1. Nameplates shall be screw mounted to NEMA 1 enclosures.
2. Nameplates shall be bonded to all other enclosure types using an epoxy or similar waterproof adhesive.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, locations of high visibility, and all access points. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with the conductor designation.

H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

K. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.
   2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
      a. Power-transfer switches.
      b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive labels.

O. Operating Instruction Signs: Self-adhesive labels.

P. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

Q. Equipment Identification:
   1. Install identification and power source nameplates at all electrical equipment.
   2. Indoor Equipment: Laminated acrylic or melamine plastic sign.
   3. Outdoor Equipment: Laminated acrylic or melamine sign.

R. Junction and Pull Box Nameplates:

1. All voltages (e.g. 480 volts, 120 volts, etc.) within pull boxes, junction boxes etc. shall be identified on the front exterior cover. Provide Signs with red background with white engraved lettering. Provide lettering a minimum of 1 inch high.

S. Panelboard Identification
1. Label branch circuit wires with associated pole number using vinyl cloth wrap around labels.
2. Provide typed as built circuit directories giving location and nature of load served. Install circuit directories in each panelboard.
3. Provide each panelboard with two nameplates. The first shall be provided by the panelboard manufacturer and shall identify the panel. The second shall be field installed by the Contractor to identify the panel's upstream power source.

END OF SECTION 260553

SECTION 261219 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

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 pad-mounted, liquid-filled, medium-voltage distribution transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.3 DEFINITIONS

A. BIL: Basic Impulse Insulation Level.

B. Bushing: An insulating structure including a central conductor, or providing a central passage for a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other.

C. Bushing Elbow: An insulated device used to connect insulated conductors to separable insulated connectors on dead-front, pad-mounted transformers and to provide a fully insulated connection. This is also called an "elbow connector."

D. Bushing Insert: That component of a separable insulated connector that is inserted into a bushing well to complete a dead-front, load break or nonload break, separable insulated connector (bushing).

E. Bushing Well: A component of a separable insulated connector, either permanently welded or clamped to an enclosure wall or barrier, having a cavity that receives a replaceable component (bushing insert) to complete the separable insulated connector (bushing).

F. Elbow Connector: See "bushing elbow" above.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pad-mounted, liquid-filled, medium-voltage transformers.
   1. Include plans and elevations showing major components and features.

a. Include a plan view and cross section of equipment base, showing clearances, required workspace, and locations of penetrations for grounding and conduits.

2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include single-line diagram.
4. Include list of materials.
5. Include nameplate data.
6. Manufacturer's published time-current curves of the transformer high-voltage fuses, with transformer damage curve, inrush curve, and thru fault current indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement.

B. Qualification Data: For testing agency.

C. Product Certificates: For transformers, signed by product manufacturer.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish the following extra materials, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
1. Three replacement power fuses or refills.
2. One refinishing kit for field touch-up of paint.
3. One 15 gallon drum of insulating oil.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.00.

2.2 PERFORMANCE REQUIREMENTS

A. Windings Material: Copper.

B. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, fully shielded, separable-elbow type, suitable for plugging into the inserts provided in the high-voltage section of the transformer. Connected in each phase of incoming circuit and ahead of any disconnecting device.

C. Winding Connections: The connection of windings and terminal markings shall comply with IEEE C57.12.70.

D. Efficiency: Comply with 10 CFR 431, Subpart K.

E. Insulation: Transformer kVA rating shall be as follows: The average winding temperature rise above a 30 deg C ambient temperature shall not exceed 65 deg C and 80 deg C hottest-spot temperature rise at rated kVA when tested according to IEEE C57.12.90, using combination of connections and taps that give the highest average winding temperature rise.

F. Tap Changer: External handle, for de-energized operation.

G. Tank: Sealed, with welded-on cover.

H. Enclosure Integrity: Comply with IEEE C57.12.28 for pad-mounted enclosures that contain energized electrical equipment in excess of 600 V that may be exposed to the public.

I. Mounting: An integral skid mounting frame, suitable to allow skidding or rolling of transformer in any direction, and with provision for anchoring frame to pad.

J. Insulating Liquids:
   1. Less-Flammable Liquids:
      a. Biodegradable and Nontoxic Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92.

K. Sound level shall comply with NEMA TR 1 requirements.

L. Corrosion Protection:

1. Transformer coating system shall be factory applied, complying with requirements of IEEE C57.12.28, in manufacturer's standard color green.

2.3 THREE-PHASE TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Electrification Products.
   2. Cooper Industries, Inc.
   3. Eaton.
   4. General Electric Company.

B. Description:
   1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with IEEE C57.12.26.

C. Compartment Construction:
   1. Double-Compartment Construction: Individual compartments for high- and low-voltage sections, formed by steel isolating barriers that extend full height and depth of compartments, with hinged, lift-off doors and three-point latching, with a stop in the open position and provision for padlocking.

D. Primary Fusing: Designed and rated to provide thermal protection of transformer by sensing overcurrent and high liquid temperature.
   1. 150-kV BIL current-limiting fuses, conforming to requirements of IEEE C37.47.
   2. Interrupting Rating: 50,000 rms A symmetrical at system voltage.
   3. Fuse Assembly: Bayonet-type, liquid-immersed, expulsion fuses in series with liquid-immersed, partial-range, current-limiting fuses. Bayonet fuse shall sense both high currents and high oil temperature to provide thermal protection to the transformer.
   4. Provide bayonet fuse assembly with an oil retention valve and an external drip shield inside the housing to eliminate or minimize oil spills. Valve shall close when fuse holder is removed and an external drip shield is installed.
   5. Provide a conspicuously displayed warning adjacent to bayonet fuse(s), cautioning against removing or inserting fuses unless transformer has been de-energized and tank pressure has been released.

E. High-Voltage Section: Dead-front design.
   1. To connect primary cable, use separable insulated connectors; coordinated with and complying with requirements of Section 260513 "Medium-Voltage Cables." Bushings shall be one-piece units, with ampere and BIL ratings the same as connectors.
   2. Bushing inserts and feed-through inserts:
      a. Conform to the requirements of IEEE 386.
      b. Rated at 200 A, with voltage class matching connectors. Provide a parking stand near each bushing well.
      c. Provide insulated protective caps for insulating and sealing out moisture from unused bushing inserts.
   3. Bushing wells configured for loop-feed application.
   4. Access to liquid-immersed fuses.

5. Dead-front surge arresters.
6. Tap-changer operator.
7. Load-Break Switch:
   a. Radial-feed, liquid-immersed type with voltage class and BIL matching that of separable connectors, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12 kA rms symmetrical.
   b. Loop-feed sectionalizing switches, using three two-position, liquid-immersed-type switches for closed transition loop-feed and sectionalizing operation. Voltage class and BIL shall match that of separable connectors, with a continuous current rating and load-break rating of 200 amperes, and a make-and-latch rating of 12 kA rms symmetrical. Switch operation shall be as follows:
      1) Position I: Line A connected to line B and both lines connected to the transformer.
      2) Position II: Transformer connected to line A only.
      3) Position III: Transformer connected to line B only.
      4) Position IV: Transformer disconnected and line A not connected to line B.
      5) Position V: Transformer disconnected and line A connected to line B.
8. Ground pad.

F. Low-Voltage Section:
   1. Bushings with spade terminals drilled for terminating the number of conductors indicated on the Drawings, and the lugs that comply with requirements of Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

G. Capacities and Characteristics:
   1. Power Rating (kVA): As indicated on the Drawings.
   2. Voltage Ratings: As indicated on the Drawings
   3. Connection:
      a. Primary: As indicated on the Drawings
      b. Secondary: As indicated on the Drawings
   4. Taps: Four 2.5 percent, full-capacity taps below rated primary voltage.
   5. Transformer BIL (kV):
      a. Primary: Comply with IEEE C57.12.26 requirements.
      b. Secondary: 30kV.
   6. Minimum Tested Impedance (Percent at 85 deg C): 2.87.
   7. K-factor: , complying with UL 1562.
   8. Comply with FM Global Class No. 3990.
   9. Comply with UL listing requirements for combination classification and listing for transformer and less-flammable insulating liquid.

H. Transformer Accessories:
   1. Drain and filter connection.
   2. Filling and top filter press connections.
   3. Stainless-steel ground connection pads.
   4. Machine-engraved nameplate, made of anodized aluminum or stainless steel.
   5. Furnish two15 kV intermediate class lightning arresters mounted in the high voltage primary compartment for surge protection.

2.4 CONTROL NETWORK

A. Controllers: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as a native device.

2.5 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."
   1. High-Voltage Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s). Sign legend shall be "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch-high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background.
   2. Arc Flash Warning Label: Provide self-adhesive warning signs on outside of high-voltage compartment door(s), warning of potential electrical arc flash hazards and appropriate personal protective equipment required.

2.6 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.90.
   1. Perform the following factory-certified routine tests on each transformer for this Project:
      a. Resistance.
      b. Turns ratio, polarity, and phase relation.
      c. Transformer no-load losses and excitation current at 100 percent of ratings.
      d. Transformer impedance voltage and load loss.
      e. Operation of all devices.
      f. Lightning impulse.
      g. Low frequency.
      h. Leak.
      i. Transformer no-load losses and excitation current at 110 percent of ratings.
      j. Insulation power factor.
      k. Applied potential, except that this test is not required for single-phase transformers or for three-phase Y-Y-connected transformers.
      l. Induced potential.
      m. Resistance measurements of all windings on rated voltage connection and at tap extreme connections.
      n. Ratios on rated voltage connection and at tap extreme connections.
      o. Polarity and phase relation on rated voltage connection.
      p. No-load loss at rated voltage on rated voltage connection.
      q. Exciting current at rated voltage on rated voltage connection.
      r. Impedance.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pad-mounted, liquid-filled, medium-voltage transformers upon delivery.
   1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.
   2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
   3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
   4. Verify that there is no evidence of insulating-liquid leakage on transformer surfaces, at weld seams, on high- or low-voltage bushing parts, and at transformer base.
   5. Verify that there is positive pressure or vacuum on tank. Check pressure gauge; it is required to read other than zero.
   6. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform with manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
   7. Verify presence of polychlorinated biphenyl content labeling.
   8. Unload transformers carefully, observing all packing label warnings and handling instructions.
   9. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:
   1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, tank, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
   2. Protect transformer termination compartments against entrance of dust, rain, and snow.
   3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and to prevent trapping air in windings. Do not tilt or tip transformers.
   4. Verify that transformer weights are within rated capacity of handling equipment.
   5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
   6. Use jacks only at corners of tank base plate.
   7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
   8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
   9. Exercise care not to damage tank base structure when handling transformer using skids or rollers. Use skids to distribute stresses over tank base when using rollers under large transformers.

C. Storage:
   1. Store transformers in accordance with manufacturer's recommendations.

2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Verify that an effective pressure seal is maintained using pressure gauges. Visually check for insulating-liquid leaks and rust spots.

D. Examine areas and space conditions for compliance with requirements for pad-mounted, liquid-filled, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:
1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:
1. Verify removal of any shipping bracing after placement.
2. Remove a sample of insulating liquid according to ASTM D 923. Insulating-liquid values shall comply with NETA ATS, Table 100.4. Sample shall be tested for the following:
   a. Dielectric Breakdown Voltage: ASTM D 877 or ASTM D 1816.
   b. Acid Neutralization Number: ASTM D 974.
   c. Interfacial Tension: ASTM D 971.
   d. Color: ASTM D 1500.
   e. Visual Condition: ASTM D 1524.
   f. Water in Insulating Liquids: Comply with ASTM D 1533.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.

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

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and IEEE C2.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting the grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors, sized as shown. Keep lead lengths as short as practicable, with no kinks or sharp bends.
   2. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft.. Bond each gate section to fence post using 1/8 by 1 inchflexible braided copper strap and clamps.
   3. Make joints in grounding conductors and loops by exothermic weld or compression connector.
   4. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure.
   5. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
   2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of transformers according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
   1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
   2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
      a. Adjust transformer taps.
      b. Prepare written request for voltage adjustment by electric utility.
   3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
   4. Report:
      a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.
   1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
   2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
   3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:
      a. Description of equipment to be tested.
      b. Discrepancies.
      c. Temperature difference between area of concern and reference area.
      d. Probable cause of temperature difference.
      e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
      f. Identify load conditions at time of inspection.
      g. Provide photographs and thermograms of deficient area.
   4. Act on inspection results according to recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 261219

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

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. Two-winding transformers.

B. Related Requirements:
   1. Section 260526 - Grounding and Bonding for Electrical Systems.
   2. Section 260529 - Hangers and Supports for Electrical Systems.
   3. Section 260533 - Raceway and Boxes for Electrical Systems.
   4. Section 260553 - Identification for Electrical Systems.

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, NEMA rating of the enclosure, compliance with the latest energy efficiency standard certification, tap configurations, insulation system type, and rated temperature rise.

C. Test and Evaluation Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.

D. Source Quality Control Submittals: Indicate results of shop tests and inspections.

E. Field Quality Control Submittals: Indicate results of Contractor furnished tests and inspections.

1.4 CLOSEOUT SUBMITTALS

A. Record Documentation: Record actual locations of transformers.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Product storage and handling requirements.

B. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers:
1. Square D Co.
2. General Electric Co.
3. Eaton Electrical.
4. Substitutions: Section 016000 - Product Requirements.

B. Description: NEMA ST 20, factory-assembled, air-cooled, dry type transformers, ratings as indicated on Drawings.

C. Operation:
1. Primary Voltage: 480V.
2. Secondary Voltage: 120/208V.
3. Insulation system and average winding temperature rise for rated kVA as follows:
4. 1-15 kVA: Class 180 with 80 degrees C rise.
5. 16-500 kVA: Class 220 with 80 degrees C rise.
6. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
7. Winding Taps:
   a. Transformers Less than 15 kVA: Two 2.5 percent below and two 2.5 percent above rated voltage, full capacity taps on primary winding.
   b. Transformers 15 kVA and Larger: Four 2.5 percent below and two 2.5 percent above rated voltage, full capacity taps on primary winding.
8. Sound Levels: NEMA ST 20.
9. Mounting:
   a. 1-15 kVA: Suitable for wall mounting or as shown on drawings.
   b. 16-75 kVA: Suitable for wall mounting or as shown on drawings.

D. Materials:
1. Ground core and coil assembly to enclosure by means of visible flexible copper grounding strap.
2. Coil Conductors: Continuous copper windings with terminations brazed or welded.
3. Enclosure: NEMA ST 20, Type 1 and suitable for the environment in which the transformer is installed as indicated on the electrical area classification drawings. Furnish lifting eyes or brackets.

E. Fabrication:
   1. Isolate core and coil from enclosure using vibration-absorbing mounts.
   2. Nameplate: Stainless steel name plate showing all the data required by the applicable codes and standards. Include the following data as minimum:
      a. Manufacturer's name.
      b. Rated kVA.
      c. Frequency (in Hz).
      d. Primary and secondary Voltage.
      e. Connection data.
      f. Insulation Class.
      g. Temperature Rise.
      h. Percent Impedance.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Production test each unit according to NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify mounting supports are properly sized and located including concealed bracing in walls.

3.2 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, in accordance with Section 260533, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Support transformers in accordance with Section 260529.
   1. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by manufacturer.
   2. Mount trapeze-mounted transformers as indicated on Drawings.

D. Install grounding and bonding in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements for inspecting and testing.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

3.4 ADJUSTING

A. Measure primary and secondary voltages and make appropriate tap adjustments.

3.5 CLEANING

A. Clean existing transformers to remain or to be reinstalled.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. MCCB: Molded-case circuit breaker.

D. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details.
   2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
   3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
   4. Detail bus configuration, current, and voltage ratings.
   5. Short-circuit current rating of panelboards and overcurrent protective devices.
   6. Include evidence of NRTL listing for series rating of installed devices.
   7. Include evidence of NRTL listing for SPD as installed in panelboard.
   8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   9. Include wiring diagrams for power, signal, and control wiring.

10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 FIELD CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
   1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
   1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Surface-mounted, dead-front cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 12.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
5. Finishes:
   a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.

E. Incoming Mains:
1. Location: Bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

F. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
   a. Plating shall run entire length of bus.
   b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

H. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices.

I. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.

J. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or

manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

G. Branch Overcurrent Protective Devices: Fused switches.

H. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
   2. External Control-Power Source: 120-V branch circuit.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

G. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. General Electric Company; GE Energy Management - Electrical Distribution.
   3. Square D; by Schneider Electric.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers:
      a. Inverse time-current element for low-level overloads.
      b. Instantaneous magnetic trip element for short circuits.
      c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
   3. MCCB Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Breaker handle indicates tripped status.
      c. UL listed for reverse connection without restrictive line or load ratings.
      d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
      e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
      f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.
1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box.

G. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

H. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

I. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

J. Install filler plates in unused spaces.

K. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

M. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as indicated.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.
   1. Measure loads during period of normal facility operations.
   2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Engineer. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262419 - MOTOR CONTROL CENTERS

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 MCCs for use with ac circuits rated 600 V and less, with combination controllers and having the following factory-installed components:
   1. Automatic power transfer.
   2. Measurement and control.
   3. Auxiliary devices.

1.3 DEFINITIONS

A. CPT: Control power transformer.

B. MCC: Motor-control center.

C. MCCB: Molded-case circuit breaker.

D. MCP: Motor-circuit protector.

E. OCPD: Overcurrent protective device.

F. PID: Control action; proportional plus integral plus derivative.

G. PT: Potential transformer.

H. SPD: Surge protective device.

I. SCR: Silicon-controlled rectifier.

J. VFC: Variable-frequency controller.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for MCCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories for each cell of the MCC.

B. Shop Drawings: For each MCC, manufacturer's approval drawings as defined in UL 845. In addition to requirements specified in UL 845, include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Factory-installed devices.
   c. Enclosure types and details.
   d. Nameplate legends.
   e. Short-circuit current (withstand) rating of complete MCC, and for bus structure and each unit.
   f. Features, characteristics, ratings, and factory settings of each installed controller and feeder device, and installed devices.
   g. Specified optional features and accessories.
2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring for each installed controller.
3. Nameplate legends.
4. Vertical and horizontal bus capacities.
5. Features, characteristics, ratings, and factory settings of each installed unit.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each MCC.

C. Source quality-control reports.

D. Field quality-control reports.

E. Load-Current and Overload Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For MCCs, all installed devices, and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

2. Manufacturer's Record Drawings: As defined in UL 845. In addition to requirements specified in UL 845, include field modifications and field-assigned wiring identification incorporated during construction by manufacturer, Contractor, or both.
3. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
4. Manufacturer's written instructions for setting field-adjustable overload relays.
5. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
6. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain MCCs and controllers of a single type from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, and marked for intended use.

D. UL Compliance: MCCs shall comply with UL 845 and shall be listed and labeled by a qualified testing agency.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver MCCs in shipping splits of lengths that can be moved past obstructions in delivery paths.

B. Handle MCCs according to the following:
1. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

2. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."

C. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside MCCs; install temporary electric heating, with at least 250 W per vertical section.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace MCC and SPD that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Rockwell Automation, Inc. – IntelliCenter.
2. Eaton.
3. Square D.

2.2 SYSTEM DESCRIPTION

A. NEMA Compliance: Fabricate and label MCCs to comply with NEMA ICS 18.

B. Ambient Environment Ratings:
1. Ambient Temperature Rating: Not less than 0 deg F and not exceeding 104 deg F, with an average value not exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity Rating: Less than 95 percent (noncondensing).
4. Altitude Rating: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics:
1. MCC Enclosure and Assembly:
a. Nominal System Voltage: 480-V ac.
b. Service Equipment Rated: No.
c. Enclosure: NEMA 250, Type 12.
2. Integrated Short-Circuit Rating for MCC:

a. Combination series rated;65 kA.
b. Fully rated;65 kA.

3. Integrated Short-Circuit Rating for Each Unit:
   a. Combination series rated;65 kA.
   b. Fully rated;65 kA.
4. Wiring Class: Class 2 Type B.
5. Bus:
   a. Horizontal Bus: 600 kA.
   b. Neutral Bus: None.
6. Main Disconnect Device:
   a. Main Disconnect: MCCB, UL 489, three pole, 300A. Manually operated, electrically tripped.
   b. SPD: UL 1449, Type 2.
7. Automatic Power Transfer: Electrically operated MCCBs, three pole.
8. Magnetic Controllers:
   a. Tag Number: As shown on the Drawings, including horsepower and FLA.
      1) Classification by Starting Method: Full voltage, non-reversing, unless otherwise shown on the Drawings.
      2) Controller Size: As shown on the Drawings complying with NEMA ICS 2.
9. Controller-Mounted Auxiliary Devices:
   a. Push Buttons and Selector Switches: Heavy-duty, type.
   b. Feeder Tap Units: Main Disconnect: MCCB, UL 489, three pole, 300 A. Manually operated, electrically tripped.

2.4 MOTOR CONTROL CENTER ENCLOSURES

A. Indoor Enclosures: Freestanding steel cabinets unless otherwise indicated. NEMA 250, Type 12 unless otherwise indicated to comply with environmental conditions at installed location.

B. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
   1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

2.5 ASSEMBLY

A. Structure:
   1. Units up to and including Size 3 shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   2. Units in Type B and Type C MCCs shall have pull-apart terminal strips for external control connections.

B. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners.

1. Interlock compartment door to require that the disconnecting means is "off" before door can be opened or closed, except by operating a concealed release device.
2. Compartment construction shall allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC.
3. The same-size compartments shall be interchangeable to allow rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

C. Bus Transition and Incoming Pull Sections: Included and aligned with the structure of the MCC.

D. Owner's Metering Compartment: A separate customer metering compartment and section with front hinged door, metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include PTs having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.

E. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in MCC; same-size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.

F. Wiring Spaces:
1. Vertical wireways in each vertical section for vertical wiring to each unit compartment; supports to hold wiring in place.
2. Horizontal wireways in bottom and top of each vertical section for horizontal wiring between vertical sections; supports to hold wiring in place.

G. Provisions for Future:
1. Compartments marked "future" shall be bused, wired and equipped with guide rails or equivalent, and ready for insertion of drawout units.
2. Compartments marked "spare" shall include provisions for connection to the vertical bus.

H. Integrated Short-Circuit Rating:
1. Short-Circuit Current Rating for Each Unit: Fully rated; 65 kA.
2. Short-Circuit Current Rating of MCC: Fully rated with its main overcurrent device; 65 kA.

I. Control Power:
1. 120-V ac; obtained from CPT integral with controller; with primary and secondary fuses. The CPT shall be of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 50 VA.

J. Factory-Installed Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.
1. Wiring Class: NEMA ICS 18, Class II, Type B-D, for starters Size 3 and smaller.

2. Control and Load Wiring: Factory installed, with bundling, lacing, and protection included. Use flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

K. Bus:
1. Main Horizontal and Equipment Ground Buses: Uniform capacity for entire length of MCC's main and vertical sections. Provide for future extensions from both ends.
2. Vertical Phase and Equipment Ground Buses: Uniform capacity for entire usable height of vertical sections, except for sections incorporating single units.
3. Phase-Bus Material: Hard-drawn copper of 98 percent minimum conductivity or tin-plated alloy, with mechanical connectors for outgoing conductors.
4. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for ground conductors, minimum size 1/4-by-2 inches. Equip with mechanical connectors for outgoing conductors.
5. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
6. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Insulation temperature rating shall not be less than 105 deg C.

2.6 MAIN DISCONNECT AND OVERCURRENT PROTECTIVE DEVICE(S)

A. MCCB : Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
1. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be shown by the position of the handle, and manual push-to-trip push button.
2. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
a. Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
b. Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
c. Time-current adjustments to achieve protective-device coordination as follows:
1) Adjustable long-time delay.
2) Adjustable short-time setting and delay to shape the time-current curve.
3) Adjustable instantaneous setting.
4) Individually adjustable ground-fault setting and time delay.
d. Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker. Provide one test set for testing the installed circuit breakers 225-A frame and higher.
e. Built-in digital ammeter display, showing load current and tripping cause.
3. Switch operator power shall be from control power specified in "Assembly" Article.

B. Trip units for circuit breakers below 250 ampere frame: thermal-magnetic trip units.

C. Trip units for 250 ampere frame circuit breakers and larger: adjustable, microprocessor-based, electronic overcurrent trip device with true three phase RMS sensing of sinusoidal and non-sinusoidal currents, and the following minimum features and functions:

1. Rating plugs shall be adjustable and interlocked so they are not interchangeable between frames and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
2. Trip mode indicators for ground fault, overload and short circuit.

D. MCC Main Disconnect Device: Fusible switch; fixed-mounted, manually operated, electrically tripped, quick-make, quick-break switch. Comply with UL 98.
1. Indication whether the switch is open or closed, and provisions for padlocking the operating handle.
2. Fuse clips and fuses.
3. Electrically tripped switches shall include the following:
a. Shunt trip.
b. Ground-fault protection, with adjustable time delay and test panel.
c. Single-phase protection, tripping the switch on loss of a source phase.
d. Blown fuse protection, tripping the switch on a blown fuse, with blown fuse indication.
e. Switch operator power shall be from control power specified in "Assembly" Article.

E. Surge Suppression: Factory installed as an integral part of the incoming feeder, complying with UL 1449, SPD Type 2.

2.7 AUTOMATIC POWER TRANSFER

A. Two-Breaker Transfer Control:
1. Transfer control, using electrically operated MCCBs, for an MCC supplied from two normally energized low-voltage power sources, designated "normal" and "standby." The circuit breakers connecting the two power sources to the load bus shall be controlled by a microprocessor-based automatic transfer control. Power for the transfer control shall be from the voltage-sensing transformers.
2. MCCBs: Fixed mounted, manually operated air-circuit breaker. Comply with UL 489.
a. MCCB shall have quick-make, quick-break, over-center switching mechanism that is mechanically trip-free, its position shall be indicated by the position of the handle, and manual push-to-trip push button.
b. Solid-state monitoring and tripping system to show system status monitoring, adjustable time-current protection, and shunt trip.
1) Interchangeable current sensors and timing circuits for adjustable time-current protection settings and status signals.
2) Trip-setting dials or interchangeable plugs to establish the continuous trip of the circuit breaker. Plugs shall not be interchangeable between frames, and the breaker may not be closed without the plug. With neutral ground-fault sensor.
3) Time-current adjustments to achieve protective-device coordination as follows:
a) Adjustable long-time delay.
b) Adjustable short-time setting and delay to shape the time-current curve.
c) Adjustable instantaneous setting.
d) Individually adjustable ground-fault setting and time delay.

4) Built-in connector to test the long-time delay, instantaneous, and ground-fault functions of the breaker.

3. In the automatic mode, the load bus is connected to the normal power source. When the normal source fails, the control shall automatically open the normal power source and close the standby source circuit breaker.
4. Sequence of Operation:
   a. Loss of Normal Power:
      1) The default operation shall be with the normal source main breaker closed and standby main breaker open. On detection of an undervoltage to the line side of the normal main breaker and after a field-adjustable time delay, the main breaker shall open and, after an additional field-adjustable time delay, the standby breaker shall close and restore power to the facility.
   b. Restoration of Normal Power:
      1) On restoration of voltage to the line side of the normal main breaker and after a field-adjustable time delay, the standby main breaker shall remain closed and a local "normal source available" pilot light shall illuminate at the MCC.
      2) Manual operation of a "Auto/Manual" switch located on the front of the MCC to shall be required to be switched into manual mode.
      3) Manual operation at the MCC shall be required to open the standby main breaker and close the normal main breaker.
      4) "Auto/Manual" switch shall be required to be switched back to auto mode to resume normal operation.
5. Field-Adjustable Transfer Parameters:
   a. Delay the transfer from the normal power source to the standby power. The time delay is to allow the load voltage to decay before reconnecting to another power source. Delay range is zero seconds to 30 minutes.
   b. Delay the initiation of the transfer sequence. The time delay is recommended to override a momentary power outage or voltage fluctuation. Delay range is zero to 120 seconds.
   c. A relay with contact that changes state when the power is available on the normal source, and a relay with contact that changes state when the power is available on the standby source.
6. Controls and Indicators: In addition to the delay setting controls, include the following:
   a. Interlocks or relay control to prevent transfer when either of the two controlled circuit breakers trip due to overcurrent or ground-fault.
   b. Three-position selector switch to select the normal source: Source 1, Source 2, or none.
   c. Transfer-control automatic and manual selector.
      1) Interlock shall prevent paralleling of the two power sources in manual mode.
   d. Open-close control switch for manual electrical operation of each controlled circuit breaker.
   e. Selector to place control into programming mode.
   f. Circuit breaker control switch for each of the normal and standby source breakers, providing open and close operation.
   g. Push button to initiate manual retransfer to the normal source when the transfer controller is in the manual mode.
   h. Meters and display to show the following:
      1) Voltage and frequency of both sources.
      2) A multiline display showing the following:

a) Set points of timers, and voltage pickup and dropout set points.
b) Date, time, and reason for minimum of the last 10 transfers. The display may show the information for one transfer at a time using a scrolling control, with the others held in memory.
c) When the control system is in the transferring process, the display shall show delay countdown in seconds.

i. LED indicators to show the following:
1) Normal source available.
2) Standby source available.
3) Normal source connected.
4) Standby source connected.
5) Load bus energized.

7. Voltage Transformers: Primary and secondary protection and disconnecting means for sensing functions and control power.
8. Voltage Sensing Relays: Microprocessor-based, IEEE device number 27/47 voltage detection relays for three-phase undervoltage protection and negative sequence voltage protection.

2.8 MAGNETIC CONTROLLERS

A. Controller Units: Combination controllers.

B. Disconnects:
1. Fusible Switch:
a. UL 98 and NEMA KS 1, heavy-duty, horsepower-rated fusible switch, with clips or bolt pads to accommodate UL 248-8 Class J fuses.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary Contacts: NC and NO, arranged to activate before switch blades open.
2. MCP:
a. UL 489, with interrupting capacity complying with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.
c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
d. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.
3. MCCB:
a. UL 489, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
c. Lockable Handle: For three padlocks and interlocks with cover in closed position.
d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.
4. Molded-Case Switch:
a. UL 489, with in-line fuse block for UL 248-8 Class J power fuses (depending on ampere rating), providing an interrupting capacity to comply with available fault currents; MCCB with fixed, high-set instantaneous trip only.
b. Lockable Handle: For three padlocks and interlocks with cover in closed position.

c. Auxiliary contacts "a" and "b" arranged to activate with molded-case switch handle.

C. Controllers: Comply with UL 508.
1. Full-Voltage Magnetic Controllers: Electrically held, full voltage, NEMA ICS 2, general purpose, Class A.
a. Classification: Nonreversing.

D. Overload Relays:
1. Melting-Alloy Overload Relays:
a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
2. Bimetallic Overload Relays:
a. Inverse-time-current characteristic.
b. Class 10 tripping characteristic.
c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d. Ambient compensated.
e. Automatic resetting.
3. Solid-State Overload Relays:
a. Switch or dial selectable for motor-running overload protection.
b. Sensors in each phase.
c. Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
d. UL 1053 Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
4. NC and NO isolated overload alarm contact, as indicated on the Drawings.
5. External overload reset push button.

2.9 CONTROLLER-MOUNTED AUXILIARY DEVICES

A. Control-Circuit and Pilot Devices: Factory installed in controller enclosure cover unless otherwise indicated. Comply with NEMA ICS 5.
1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.
a. Push Buttons: Unguarded types; momentary contact unless otherwise indicated.
b. Pilot Lights: LED types; colors as indicated on the Drawings; push to test.
c. Selector Switches: Rotary type.

B. Elapsed-Time Meters: Heavy duty with digital readout in hours; resettable.

C. Meters: Panel type, 2-1/2-inch minimum size with 90- or 120-degree scale and plus or minus 2 percent accuracy, with selector switches having an off position.

D. Auxiliary Dry Contacts: NC NO Reversible NC/NO.

E. Control Relays:
1. Time Delay: Auxiliary and adjustable pneumatic time-delay relays.

2. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections and adjustable undervoltage, overvoltage, and time-delay settings.

2.10 MEASUREMENT AND CONTROL DEVICES

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
1. PTs: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. CPTs: Dry type, mounted in separate compartments for units larger than 3 kVA.
4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, for selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker and ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Listed or recognized by a nationally recognized testing laboratory.
2. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
3. Switch-selectable digital display of the following values with the indicated maximum accuracy tolerances:
a. Phase Currents, Each Phase: Plus or minus 1 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Three-Phase Real Power (Megawatts): Plus or minus 2 percent.
e. Three-Phase Reactive Power (Megavars): Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
j. Contact devices to operate remote impulse-totalizing demand meter.
4. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Control Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.

D. Motor Protection Relays
1. Programmable motor protection relays: Solid state, panel mounted, Eaton MP-3000; General Electric Multilin 239, or equal, furnished complete with potential and current transformers, zero sequence ground fault transformer and RTD input module.
2. Provide the following protective functions.

a. Motor thermal overload, with thermal lockout to prevent trip reset after an overload trip.
b. Ground fault protection.
c. Phase current heating model to calculate motor thermal capacity during starting and running states.
d. Independent running protection during acceleration.
e. Phase and residual overcurrent elements
f. Unbalance/single phase
g. Load-loss (undercurrent)
h. Rapid trip/mechanical jam
i. Motor locked/stall protection

3. Over-temperature protection: provide configurable thermistor or RTD inputs, including alarm and trip settings, and associated TRIP or ALARM outputs. The following functionality shall be provided:
   a. PTC or NTC Thermistor input.
   b. Assign RTD input as "Off", "Stator" or "Bearing" type.
   c. Four different RTD types: 100 Ohm Platinum, 120 Ohm Nickel, 100 Ohm Nickel, or 10 Ohm Copper.
   d. RTD sensor fail alarm.
4. Provide monitoring and metering functions
   a. Current: RMS Values of per Phase, Percent of Motor Load, Current Unbalance, Ground
   b. Temperature of each RTD and/or thermistor input
   c. Provide data in the form of trending or data logger, sampling and recording up to eight actual values at an interval defined by the user. Several parameters shall be trended and graphed at sampling periods ranging from 1 second up to 1 hour. The parameters which can be trended by the Setup software shall be: Phase Currents A, B, and C, Motor Load, Current Unbalance, Ground Current, and Thermal Capacity Used
   d. The relay shall include one transducer output with a settable DC output range of 0 to 20 mA, 4 to 20 mA or 0 to 1 mA, which may be assigned to motor load, average phase current, thermal capacity, and any of the three optional RTDs.
   e. Latest trip report containing cause, phase, ground, current unbalance, and RTD temperatures.
   f. An immediate Overload Alarm feature shall be provided as an early alert during overload conditions.
   g. The relays shall retain in non-volatile memory, a trip record of the last 5 causes of trip.
   h. The relay shall monitor total motor running time (including start conditions) and the maximum average current present during the last successful start.
   i. The relay shall have starter failure detection feature which shall produce an alarm in the event that the motor relay does not detect a starter/breaker open condition after a trip is initiated.
   j. The relay shall have the capability to display up to 5 user programmable messages to scan sequentially when the motor relay is left unattended. The user shall be able to select from any setpoint or actual value message to be added to the default message queue. Under normal conditions, if no front panel activity is detected within a settable time, the screen shall sequentially display messages.
5. User Interfaces: Include the following:
   a. A large 40-character LCD display, and navigation keys.

b. Indicator LEDs on the front panel which shall provide a quick visual indication of status.
c. Serial communication: two wire RS485 link operating at 1200 – 19200 bps. Open protocol, ModBus RTU for read/write commands shall be included in the relay instruction manual.
d. Five switch inputs shall be provided for setpoint access, emergency restart, external reset, and two user programmable option switches.
e. The relay shall accept AC/DC control power.
f. The relay shall be capable of being set by Windows-based, easy to use, setup graphical terminal interface.

6. To make the data acquisition more efficient, the motor relay shall provide a User Definable Memory Map, which shall allow a remote computer to read up to 120 nonconsecutive data registers by using one Modbus packet. The User Definable Memory Map shall be programmed to join any memory map address to one in the block of consecutive User Map locations, so that they can be accessed by means of these consecutive locations. The User Definable area shall have two sections:
   a. A register index area containing 120 actual values or setpoints registers
   b. A Register area containing the data located at the addresses in the Register Index
   c. A simulation feature shall be included to allow testing without the need for external current inputs.

2.11 NETWORK COMMUNICATIONS

A. Provide interface hardware, cabling, and software to enable the following microprocessor-based devices to communicate with the plant-wide Ethernet/IP network:
   1. Motor controllers.
   2. Solid-state reduced voltage starters.
   3. Variable frequency drives.
   4. Metering devices.
   5. Motor protection relays.

B. The MCC shall have Ethernet wiring incorporated into its design.
   1. The MCC shall have factory installed industrial Ethernet cabling incorporated throughout the vertical section across the entire lineup
   2. Each motor starter, electronic overload relay, power monitor, AC drive, and soft starter unit in the MCC shall be supplied with a means to communicate via EtherNet/IP network
   3. Plug-in units should be able to move around without impacting the network
   4. Maintenance activities should be able to be performed without impacting the network

C. Industrial Ethernet Switch.
   1. The MCC shall have managed industrial Ethernet switch(s) with Ports to connect each EtherNet/IP enabled device
   2. Ethernet Switches shall be provided with spare ports to accommodate network expansion and future plug-in unit inserts
   3. The managed industrial Ethernet switch shall deliver optimal network security, network resiliency (if needed), and flexibility. The functionality should include port-based control/prioritization, switch-level ring support, VLAN segmentation, and other Layer-2 switch features

4. The managed industrial Ethernet switch shall have the ability to include, if needed, Gigabit ports, CIP Sync functionality, Network Address Translation (NAT), and an Industrial SD Card
5. The managed industrial Ethernet switch shall include redundant terminal blocks for customer supplied/connection of an external 24V DC UPS

D. Industrial Ethernet Switch Layout.
   1. Layout – Fixed-Mount Switch Unit.
      a. The managed industrial Ethernet Switch shall be mounted in a fixed-mount, Switch Unit in the bottom of the section.
      b. The industrial Ethernet cable shall connect each switch to one another in a linear topology.
      c. The Switch Unit shall be provided with a locking latch.
      d. The Switch Unit shall be provided with a door mounted viewing window.
      e. The Switch Unit shall be provided with a door mounted external network connector.

E. Industrial Ethernet Cabling.
   1. Industrial Ethernet Cable Ratings
      a. The industrial Ethernet cable shall be 600V UL Category 5e PLTC rated
      b. The use of a 300V rated cable is not acceptable
      c. Ethernet Switch-to-Device cable labels shall be located on both ends of the cable to specify where the cable is connected to on both ends
      d. A detailed Ethernet network table and Ethernet network diagram specifying IP addresses, subnet masks, device locations, cable label details, and 24V DC capacities shall be included in the MCC documentation
   2. Layout – Homerun (direct switch-to-device) Ethernet Connections
      a. An industrial Ethernet cable shall be routed from the managed industrial Ethernet Switch directly to the EtherNet/IP device in each unit.
         1) The industrial Ethernet cable shall be routed through the top or bottom horizontal wireway and transition through the vertical wireway directly to the EtherNet/IP device.
         2) The industrial Ethernet cable shall be secured to vertical wireway tie bars.
      b. The EtherNet/IP device within each unit shall be factory connected to the industrial Ethernet switch directly by using a 600V – UL rated Category 5e PLTC rated industrial Ethernet cable.
   3. Power Supplies.
      a. Power supplies shall provide 24V DC for the devices that require it.
      b. The MCC manufacturer shall check the user's design to confirm that adequate power supplies have been specified to conform with network requirements.
      c. Power supply output shall be rated 8 A, 24V DC.
      d. Power supplies shall be Allen-Bradley Bulletin 1606-XLS240E or approved equal
      e. Power supply units shall be provided with a buffer module to provide a minimum of 500 ms ride-through at full load (the buffer module is optional for the standard Ethernet power supply).
      f. Buffer modules shall be Allen-Bradley Bulletin 1606-XLBUFFER or approved equal.
      g. Two (2) 24V DC adapters allowing four (4) power connections shall be provided:
         1) In each vertical wireway of standard sections to simplify installation, relocation and addition of plug-in units.

2) Each 24V DC adapter in the vertical wireway shall be connected to the power supply.

h. The power supplies units shall be provided with a door mounted external 120V AC connection for laptop power and Ethernet network connection

i. Redundant 24V DC power shall be provided for all Ethernet enabled devices. Choose one type of 24V DC redundancy for the MCC application as they are mutually exclusive:

1) A Redundancy Unit shall be included that provides the capability of interconnecting two independent power supplies in a redundant way (N+1) and whose output is connected to the 24V DC circuit. The Redundancy Unit shall be powered by one of the following options:

a) Two Rockwell Automation-supplied 24V DC power supply units

b) One Rockwell Automation-supplied 24V DC power supply unit and one external power input provided by the customer

c) Two external 24V DC power inputs provided by the customer

2) Two 8 A power supply modules shall be placed in the same power supply unit and wired in parallel with blocking diodes whose output is connected to the 24V DC circuit

F. EtherNet/IP Interface for Motor Starter Units.

1. Motor starter units shall have an electronic overload relay that incorporates the following features:

a. Built-in EtherNet/IP communication

b. Overload relay I/O powered by using 120V AC

c. Status indicators for status indication

d. Overload relays shall have a reset button on the outside of the unit door

e. Selectable trip of NEMA Class 5 to 30. Unless indicated, the trip class shall be set for NEMA Class 20 operation

f. Up to six (6) inputs and three (3) outputs of direct I/O. Additional I/O can be provided with an add-on module to the overload relay. Input voltage shall match the overload relay power voltage

g. Protective functions

1) Functions shall provide a programmable trip level, warning level, time delay, and inhibit window

2) Protective functions shall include Thermal overload, Phase loss, Stall, Jam, Underload, Current imbalance, Remote trip, and PTC thermistor input

3) Ground fault protection is required

a) If ground fault protection is required, the protection range shall be 20 mA to 5 A

4) PTC Thermistor input is not required

5) Voltage protection is required

a) Input fusing shall not be used on NEMA 3 and smaller starters

h. Current monitoring functions shall include phase current, average current, full load current, current imbalance percent, percent thermal capacity utilized, and ground fault current (if required)

i. Voltage, energy, and frequency measuring capabilities shall be included when voltage protection is required

j. Diagnostic information shall include device status, warning status, time to reset, trip status, time to overload trip, and history of last five trips

k. Preventive maintenance information shall include Allowable starts per hour, required Time between starts, Starts counter, Starts available, Time until next start, total operating hours, and elapsed operating time
l. Overload relay shall include an on-board logic processor to allow basic logic to be performed within the overload relay based on network data and the status of the inputs to the overload relay
m. The overload relay shall support the following CIP messaging types: Polled I/O messaging, Change-of-state/cyclic messaging, Explicit messaging, Group 4 offline node recovery messaging, and Unconnected Message Manager (UCMM)
n. The overload relay shall provide the following functions to minimize network configuration time: Full parameter object support, Configuration consistency value, and Add-on Profile
o. The overload relay shall include a E300 Control Station connected to the overload relay by a single cable

2. The overload relay shall be Allen-Bradley E300™ model or approved equal

G. EtherNet/IP Interface for Variable Frequency AC Drives and Solid-State Reduced Voltage Motor Controllers.
1. The EtherNet/IP communication interface shall be supplied to allow for communication between the solid-state component and the Ethernet network

H. EtherNet/IP Interface for Other Units.
1. Provide an EtherNet/IP interface for other units as indicated on the contract drawings
2. Refer to the contract drawing wiring diagrams for points to be monitored

I. Programming and Testing.
1. The MCC manufacturer shall load the IP Address and Subnet Mask into each unit and Ethernet switch
2. The IP Address shall be as indicated on the contract drawings or as provided by the contractor
3. The MCC manufacturer shall test the MCC to ensure that each unit communicates properly prior to shipment
4. The MCC manufacturer shall provide a disk containing applicable electronic data sheet (EDS) files for the EtherNet/IP devices
5. The IP Address shall be visible on the unit Nameplate for any units containing an EtherNet/IP enabled device
6. All firmware will be provided with the same revision level of firmware across all similar intelligent electronic devices
a. E300 overload relays
b. PowerFlex® 523, PowerFlex 525 drives
c. PowerFlex 753, PowerFlex 755 drives
d. Stratix® 5700 switches
e. PowerMonitor™ 5000 energy meters
f. SMC™ Flex starters

J. As a minimum transmit the following data from each starter over the network:
1. Percent of operating full load current.
2. Percent thermal memory.
3. Operating status and fault codes.
4. Start/Stop control.
5. Trip reset.

6. Average current.
7. Ground fault detection.
8. Fault log.
9. Current level warning (adjustable).
10. Under-load warning (adjustable).

K. Communicate metering and trip device data to a plant-wide power management network.

2.12 SOFTWARE

A. Preconfigured Software
1. The software shall be capable of viewing multiple MCC lineups.
2. The software communication driver shall allow the software to be installed and operated on the EtherNet/IP network.
3. The software shall be capable of functioning as a standalone software package or as an ActiveX control in a Human Machine Interface (HMI).
4. The software shall be capable of displaying the following.
   a. Elevation View
      1) Dynamically displays status information based on reading data from devices in the MCC lineup.
      2) Sizeable view to allow ease of viewing multiple MCC lineups.
      3) Unit nameplate information.
      4) Unit status indicators (ready, running, warning, fault, no communication).
   b. Unit Monitor View
      1) Preconfigured for a specific unit.
      2) Real time monitoring via analog dials and trending.
      3) Data configurable for customized viewing.
      4) Modifying device parameters.
   c. Spreadsheet View
      1) User configurable for customized monitoring.
      2) Sorting and cascading functions.
      3) Custom user fields.
   d. Event Log
      1) Track history of MCC unit.
      2) Automatic logging of trips, warnings, and changes.
      3) Manual entry of events.
   e. Documentation
      1) Front elevation drawings.
      2) Unit wiring diagrams.
      3) User manuals.
      4) Spare parts lists.

2.13 SOURCE QUALITY CONTROL

A. MCC Testing: Test and inspect MCCs according to requirements in NEMA ICS 18.

B. MCCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION

A. NEMA Industrial Control and Systems Standards: Comply with parts of NEMA ICS 2.3 for installation and startup of MCCs.

B. Floor Mounting: Install MCCs on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification of MCC, MCC components, and control wiring.
   1. Identify field-installed conductors, interconnecting wiring, and components.
   2. Install required warning signs.
   3. Label MCC and each cubicle with engraved nameplate.
   4. Label each enclosure-mounted control and pilot device.
   5. Mark up a set of manufacturer's connection wiring diagrams with field-assigned wiring identifications and return to manufacturer for inclusion in Record Drawings.

B. Operating Instructions: Frame printed operating instructions for MCCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of MCCs.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches within enclosed controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 CONNECTIONS

A. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multipole enclosed

controller. Remove front panels so joints and connections are accessible to portable scanner.

b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multipole enclosed controller 11 months after date of Substantial Completion.

c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Submit calibration record for device.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

6. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

D. MCCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to NETA Acceptance Testing Specification and manufacturer's written instructions.

3.8 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.

B. Adjust overload relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

E. Set field-adjustable circuit-breaker trip ranges

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262419

SECTION 262505 – 480V CONTROL PANELS

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 industrial control panels with the following features:
   1. Enclosure.
   2. Main circuit breaker.
   3. Motor controllers.
   4. Control and monitoring devices.
   5. Accessories.
   6. Identification.

B. Related Requirements:
   1. Division 26 for electrical work
   2. Division 27 for communications wiring
   3. Division 40 for process automation requirements
   4. Division 46 for water and wastewater equipment requirements

1.3 DEFINITIONS

A. CPT: Control power transformer

B. GFCI: Ground-fault circuit interrupter

C. MCCB: Molded-case circuit breaker

D. MCP: Motor circuit protector

E. NEC: National Electrical Code

F. RVSS: Reduced voltage soft start

G. RVAT: Reduced voltage autotransformer start

H. SCCR: Short-circuit current rating

I. SPD: Surge protective device

J. UL: Underwriter’s Laboratories

K. VFC: Variable frequency motor controller. See VFD

L. VFD: Variable frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

A. Product Data: For each control panel.
   1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
   2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each control panel.
   1. Include dimensioned plans, elevations, sections, and details.
   2. Bill of materials with part numbers, cross-referenced to plans.
   3. Nameplate schedule.
   4. Conduit entrance locations and mounting details.
   5. Power and control schematics.
   6. Certification for compliance with UL 508A.
   7. Identification per NEC 409.110.

1.5 INFORMATIONAL SUBMITTALS

A. Startup reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following if applicable:
   1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.
   3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
   5. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
   6. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than two of each size and type.
2. Power fuses: Equal to 10 percent of total quantity installed for each size and type, but no fewer than three of each size and type.
3. Corrosion Inhibitor: Equal to 100 percent of total number of control panels. (One spare per panel.)

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store control panels indoors in clean, dry space with uniform temperature to prevent condensation. Protect control panels from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.10 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace control panels that fail in materials or workmanship within specified warranty period.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
   1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for control panels clearances between control panels and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).

E. Comply with NEMA ICS 6: Industrial Control and Systems: Enclosures.

F. Comply with UL 1203 for control panels located in hazardous (classified) locations.

G. Comply with NFPA 70.

H. Comply with UL 508A.

I. Complete and fully functional control to manually or automatically operate the control system as specified herein and in other applicable sections of these specifications. Include manufacturer's recommended safety devices to protect operators. All control devices, unless specified otherwise, mounted in the Control Panel.

J. The control panel shall operate on a power supply of 480 volts, 3-phase, 60 hertz unless otherwise noted.

K. Control panel consists of a main circuit breaker, motor circuit protector (MCP) and motor controller for each motor, and a 120-volt control power transformer (fused on primary and secondary) along with other devices specified. Mount all control components in one common enclosure.

L. Operation of motors will be manually or automatically. Stager control of multiple motors to prevent simultaneous motor starting.

M. All electronic control equipment (i.e. controllers, isolators, signal boosters, transmitters, PLC's, etc.) shall be as specified in Division 40.

N. Control panels containing PLC's shall contain UPS or battery ride-through for the PLC in accordance with Division 40 specifications.

O. SCCR: Control panels with main breakers of 125 amps or less shall have SCCR of 65kA, unless specifically noted elsewhere.

2.2 ENCLOSURES

A. Enclosures: Surface-mounted, dead-front cabinets rated for environmental conditions at installed location. Unless noted elsewhere, NEMA rating shall be NEMA 4X, Type 316 stainless steel, minimum 14 gauge.

B. Construction: The door shall be mounted via continuous stainless steel hinged and provided with a pad-lockable vault type 3-point latch. The enclosure shall be equipped with a door and shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to enclosure with collar studs. Door(s) shall be interlocked with main circuit breaker and provided with pad-locking provision.

C. All motor branch circuit breakers, motor starters and control relays shall be of highest industrial quality, securely fastened to the removable back panels with screws and lock washers. Back panels shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any component.

D. Operating handle for main circuit breaker: flange mounted.

E. Provide additional temperature control if required to meet UL temperature rating of internal components. If forced air ventilation is required, the enclosure shall be pressurized. Air filters shall be of commercially available types and sizes.

F. All operating control and instruments shall be securely mounted on the exterior door. All controls and instruments shall be clearly labeled to indicate function. All exterior mounted equipment shall be NEMA 4X.

G. Print storage pockets shall be provided on the inside of each panel. Pocket shall be of sufficient size as required to hold all prints necessary to service the equipment.

H. Where the project has multiple control panels, suggest including a table of SCCR requirements for the paragraph below – design engineer to perform short circuit calculations to confirm.

2.3 COMPONENTS

A. Main Breaker: Thermal-magnetic air circuit breaker, Schneider Electric/Square D PowerPact Type BG (125 amp frame, 35kAIC) or equal.

B. MCP: Molded case motor circuit protector with adjustable magnetic trip only, Schneider Electric/Square D “Mag-Gard” or equal.

C. Motor Controller:
   1. Full Voltage Motor Starting: Open frame, across-the-line, NEMA-rated magnetic motor starter, Schneider Electric/Square D Class 8536 or equal. Solid state overloads with Class 10/20 selectable tripping. Submersible motors shall use Class 10 trip curve.
   2. Reduced voltage motor starting: VFD

D. Overload relays shall be self-powered solid-state type and provide the following features: tamper guard over trip adjustment setting, ambient insensitive, harmonic immunity, phase loss and phase unbalance protection, manual reset, and push-to-test.

E. Overload reset buttons shall be mounted on dead front door.

F. Normally open and normally closed auxiliary motor overload contacts wired to terminal blocks shall be provided for each motor starter within the control panel.

G. SPD: The control panel shall be provided with a surge protective device (SPD) rated for 100kA per mode for the incoming power and in compliance with Section 264313. SPD shall be mounted within the control panel enclosure. Lead lengths shall not be longer than 12 inches from the main circuit breaker.

H. Control Power Transformer: 480-120V CPT, fused on primary and secondary sides, capacity as required.

2.4 CONTROL DEVICES AND ACCESSORIES

A. Control Operators and Indictors:
   1. Heavy duty type, full size (30.5mm), NEMA 4X as required.
   2. Each motor shall include Hand-Off-Auto selector switches to permit override of automatic control and manual actuation of shutdown.

B. Indicating Lights:
   1. LED, full size (30.5mm), full voltage and push-to-test type.
   2. Indicators shall be provided for individual motor run and an indicator for each failure condition.

C. Elapsed Time Meters (ETM):
   1. Six (6) digit, non-reset elapsed time meter to indicate the total running time of each motor in "hours" and "tenth of hours". Series T50 as manufactured by the ENM Company or equal.
   2. Provide an ETM for each motor.

D. Failure Alarm Horn and Beacon Light:
   1. Alarm horn: weatherproof rated with gasket (Federal Signal Corporation, Cat. #350 or equal) for NEMA 4X applications.
   2. Alarm beacon: Red lens and solid-state flasher (Ingam Products Inc. LRX-40 or equal) for NEMA 4X applications.
   3. All lift station pump control panels shall include alarm horn and light for summary alarm condition.
   4. Silence and reset pushbuttons shall also be furnished. A common failure reset pushbutton shall be provided to reset the alarm conditions (reset shall occur only if fault condition has been cleared).

E. Relays:
   1. Control relays shall be 10 amp rated contacts (minimum), 11 pin with mounting base, 3PDT (minimum), with LED indicators to show relay status, relays shall be manufactured by Potter Brumfield or equal.
   2. Timing relays shall be solid state, with pin (octal) and bases, relays shall be T-series as manufactured by Diversified Electronics Inc. or equal.
   3. Intrinsically safe relays shall be solid state type with 5 amp output contacts, suitable for use on 120 volt, 60 hertz power supply and shall be Factory Mutual approved for devices in Class 1, Division 1 hazardous atmospheres. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc. or equal.

F. A duplex GFCI utility receptacle (circuit breaker protected) providing 120 volts, 60 Hertz, single phase current shall be mounted on the side of the enclosure.

G. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by Divisions 40, 26 and as shown on the Drawings.

H. Corrosion Inhibitor Emitter: Inclusion of an industrial corrosion inhibitor emitter, selected by the manufacturer, to protect internal components of control panel from corrosion for up to one year.

I. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

2.5 WIRING

A. Power and control wire shall be 600 Volt class, Type MTW insulated stranded copper and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.

B. Wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 Volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.

C. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.

D. Terminal blocks shall be 600 Volt heavy duty rated, tubular clamp type. Terminal strips shall be Allen Bradley catalog #1492-CA-1 or equal.

E. A copper ground bar with sufficient terminals for all field and panel ground connections shall be provided.

F. All signal wiring entering and exiting the control panel shall be provided with surge protection. Surge protection shall be as specified in Division 40.

G. An 8-inch (minimum) clear space within the enclosure shall be provided horizontally along the entire top and bottom of the control panel. A 4-inch (minimum) clear space within the enclosure shall be provided vertically along the entire sides of the control panel. No devices, terminals, etc. shall be installed within this space, the space shall be provided for field conduit and wiring access only.

2.6 IDENTIFICATION

A. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers.

B. The control diagrams and overload tables shall be laminated to the inside of the door except where door space is limited the laminated documents shall be in the print storage pocket.

C. The control panel shall be provided with nameplates identifying each component, selector switches, pilot lights, etc. Nameplates shall be permanently affixed using an epoxy process (inner door nameplates shall be fastened with stainless steel screws). Nameplates shall be laminated plastic, engraved black letters with a white background.

D. All control panels shall be provided with two nameplates located on the exterior door. The first nameplate shall identify the control panel name. The second nameplate shall identify the power source.

E. Where applicable provide a nameplate which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Letters shall be black on a high visibility yellow background.

F. Each terminal at terminal blocks shall be individually labeled.

G. Incoming phase conductor terminals shall be clearly identified. All wiring within the control panel shall be color coded or coded using electrical tape in sizes where colored insulation is not available. The following coding shall be used.

System	**Wire**	**Color**
Incoming line voltage	Phase conductors	Black
	Ground	Green
	Neutral (as required)	Gray
Internal control voltage	AC	Red
Internal control voltage	DC	Blue
External source	All	Yellow

2.7 FACTORY TESTS

A. Inspect and test control panel for correct operation. Test each circuit for continuity, short circuits, and ground faults.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Inspect anchorage, alignment, grounding, and clearances.

C. Compare equipment nameplate data for compliance with Drawings and Specifications.

D. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

E. Motor Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.2 STARTUP SERVICE

A. Complete startup checks according to manufacturer’s written instructions.

B. Verify motor running protection is appropriate for actual motors installed.

C. Test control panel with all field wiring connected. Set adjustable set points and time delays for proper operation of equipment. Adjust as required.

D. Perform infrared inspection of panel interior during periods of maximum possible loading. Remove all necessary covers prior to the inspection. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.

E. Prepare test and inspection reports.

F. Install a set of legible “as built” control panel drawings (11x17 or 8.5 x 11), in the storage pocket.

3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain equipment.

END OF SECTION 2625050

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SECTION 262726 - WIRING DEVICES

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. Standard-grade receptacles, 125 V, 20 A.
   2. GFCI receptacles, 125 V, 20 A.
   3. Toggle switches, 120/277 V, 15 A.
   4. Wall plates.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
   1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
   2. Devices shall comply with requirements in this Section.

F. Device Color:
   1. Wiring Devices Connected to Normal Power System: **Black** unless otherwise indicated or required by NFPA 70 or device listing.
   2. SPD Devices: Blue.

G. Wall Plate Color: For plastic covers, match device color.

H. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Eaton (Arrow Hart).
      b. Hubbell Incorporated; Wiring Device-Kellems.
      c. Leviton Manufacturing Co., Inc.
      d. Pass & Seymour/Legrand (Pass & Seymour).
   2. Description: Two-pole, three-wire, and self-grounding.
   3. Configuration: NEMA WD 6, Configuration 5-20R.
   4. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A <**Insert drawing designation**>:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: Two-pole, three-wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

C. Corrosion-Resistant Receptacles, 120V, 20A:
1. Manufacturers: Hubbell, Eaton, Legrand.
2. Description: Two-pole, three-wire, and self-grounding. High visibility yellow nylon face, nickel plated brass or copper alloy power contacts.
3. Configuration: WD 6, Configuration 5-20R.
4. Standards: Comply with UL 498.
5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Corrosive Locations" Article.

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

2.4 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Eaton (Arrow Hart).
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).
2. Standards: Comply with UL 20 and FS W-S-896.

B. Three-Way Switches, 120/277 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eaton (Arrow Hart).
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Manufacturing Co., Inc.
   d. Pass & Seymour/Legrand (Pass & Seymour).
2. Comply with UL 20 and FS W-S-896.

2.5 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Unfinished Spaces: Galvanized steel.
   3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:
   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
   4. Existing Conductors:
      a. Cut back and pigtail or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.
c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:
1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:
      a. Control circuits.
      b. Motor-control centers.
      c. Enclosed controllers.
      d. Enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components. Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
   2. Current-limitation curves for fuses with current-limiting characteristics.
   3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
   4. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," and Section 017823 "Operation and Maintenance Data," include the following:
   1. Current-limitation curves for fuses with current-limiting characteristics.
   2. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
   3. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bussmann, an Eaton business.
   2. Edison; a brand of Bussmann by Eaton.
   3. Littelfuse, Inc.
   4. Mersen USA.

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
   1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
   4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting.
   5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
   6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
   7. Type T: 250-V, zero- to 1200-A rating, 200 kAIC, very fast acting.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Power Electronics Circuits: Class J, high speed.
   2. Control Transformer Circuits: Class CC, time delay, control transformer duty.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Related Requirements:
   1. Section 262505.00 for 480V control panels.
   2. Division 46 for water and wastewater equipment requirements.

1.3 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller. See VFD.

L. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
1. Include mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Certificates: For each VFC from manufacturer.

C. The VFD supplier shall submit written confirmation that the motor characteristics (i.e. torque type, FLA, etc.) have been coordinated with the supplier of the driven equipment and that the VFDs being supplied are matched properly for the driven load.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
2. Indicating Lights: Two of each type and color installed.
3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. Rockwell Automation, Inc.
   3. Schneider Electric USA, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 97 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
   7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
   8. Humidity Rating: Less than 95 percent (noncondensing).
   9. Altitude Rating: Not exceeding 3300 feet.
   10. Vibration Withstand: Comply with NEMA ICS 61800-2.
   11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   13. Speed Regulation: Plus or minus 5 percent.
   14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

I. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:
   1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
   2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
   3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   4. Under- and overvoltage trips.
   5. Inverter overcurrent trips.
   6. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
   7. Critical frequency rejection, with three selectable, adjustable deadbands.
   8. Instantaneous line-to-line and line-to-ground overcurrent trips.
   9. Loss-of-phase protection.
   10. Reverse-phase protection.
   11. Short-circuit protection.
   12. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: UL 489, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
   2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
   3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

2.3 PERFORMANCE REQUIREMENTS

2.4 CONTROLS AND INDICATION

A. Controls shall, as a minimum, perform the control logic indicated on the Contract Drawings and as specified herein.

B. Status Lights: Door-mounted LED indicators displaying the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

C. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

D. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

E. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

F. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
      b. A minimum of six multifunction programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:
      a. 4- to 20-mA dc.
      b. Potentiometer using up/down digital inputs.
      c. Fixed frequencies using digital inputs.
   3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:
      a. Output frequency (Hz).

b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

G. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
1. Number of Loops: One.

2.5 LINE CONDITIONING AND FILTERING

A. Output Filtering:
1. The filter shall be comprised of passive components only. It shall limit peak voltage at the motor terminals to 150% or less of the VFD's DC bus voltage for motor leads of 1000 feet or shorter. The maximum dV/dT of the waveform pulses at the motor terminal shall be 200 volts per microsecond. Filter shall be UL Listed and have an insertion loss of 3% of rated voltage maximum. Filter shall be MTE Series A dV/dT Filter or equivalent.

2.6 OPTIONAL FEATURES

A. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

B. Remote digital operator kit.

C. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.7 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Corrosion Areas: Type 4X Type 316, stainless steel.

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
1. Push Buttons: Unguarded.
2. Pilot Lights: LED, Push to test.
3. Selector Switches: Rotary type.

B. NC NO Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable pneumatic time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:
   1. Elapsed-time meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Spare control-wiring terminal blocks; unwired.

2.9 ADDITIONAL CONSTRUCTION REQUIREMENTS

A. Disconnect handle height shall not exceed NEC requirements with VFC is located on 4-inch high housekeeping pad.

B. VFC’s shall utilize 115 VAC control power for operator devices, cooling fans, motor space heaters and external control circuits. Control power transformer shall be fused on the primary and secondary. Control circuits shall be isolated from power circuits.

C. VFC shall include a copper ground bus.

D. All bus and exposed copper shall be tin plated.

E. All floor mounted enclosures shall have complete 18" (minimum) clear space in bottom of the cubical for line, motor and field cable terminations. All wall mounted enclosures shall have complete 12" (minimum) clear space in bottom of the enclosure for line, motor and field cable terminations.

F. A switchable fluorescent light shall be provided within each floor mounted section of the enclosure.

G. Barriers shall be provided on terminals that remain energized with the power disconnect OFF.

H. All circuit boards shall be conformal coated to help protect them from hydrogen sulfide gases.

I. Identification
   1. All wiring shall be numbered at each end with typed sleeve type labels at each termination. Labels shall correspond to the wiring diagrams. Wiring less than 6 inches may be numbered at only one end.
   2. Provide warning signs on terminals that are energized with the power disconnect OFF.

3. Provide 2-inch by 5-inch, nominal, engraved three-layer laminated plastic master nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black letters with white background core, 3/8-inch high lettering and shall indicate equipment designation as shown on the Drawings.
4. Provide legend plates or 1-inch by 3-inch engraved nameplates with 1/4-inch lettering for identification of pilot devices and meters.
5. Provide permanent warning signs as follows:
   a. "DANGER - HIGH VOLTAGE - KEEP OUT" on all enclosure doors.
   b. "WARNING - HAZARD OF ELECTRIC SHOCK - DISCONNECT POWER BEFORE OPENING OR WORKING ON THIS UNIT".

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to its specified motor.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

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

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in each fusible-switch VFC.

D. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:
1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
   c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Field test all the hardwired discrete and analog connections and any software communication (Ethernet, Profibus, ControlNet, Modibus, etc.) that are connect to remote control equipment when the VFC is placed in remote. The manufacturer shall at a minimum verify with the proper testing equipment that the following can be achieved:
   a. The drive can be started and stopped remotely
   b. The drive can have its speed changed remotely
   c. The remote equipment can read the VFC discrete status information.
   d. The remote equipment can read the VFC speed feedback information.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

3.10 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

B. Replace all cabinet ventilation filters upon commencement of the Contract warranty period.

END OF SECTION 262923

SECTION 263600 - TRANSFER SWITCHES

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 automatic transfer switches rated 600 V and less.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
   2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Features and operating sequences, both automatic and manual.
      b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:
   1. Member company of NETA.
      a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
   1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
   2. Short-time withstand capability for three cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

K. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

L. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
   1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
   2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
   3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
   4. Accessible via front access.

M. Enclosures: General-purpose NEMA 250, Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton.
   2. Lake Shore Electric Corporation.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
   1. Limitation: Switches using contactor-based components are unacceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching.
   4. Conductor Connectors: Suitable for use with conductor material and sizes.
   5. Material: Tin-plated aluminum.
   6. Main and Neutral Lugs: Compression type.
   7. Ground Lugs and Bus-Configured Terminators: Compression type.
   8. Ground bar.
   9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
   1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Electric Nonautomatic Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

G. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

H. Transfer Switches Based on Molded-Case-Switch Components: Comply with UL 489 and UL 869A.

I. Automatic Transfer-Switch Controller Features:
   1. Controller operates through a period of loss of control power.
   2. Undervoltage Sensing for Each Phase of Normal and Alternative Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
   4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   5. Test Switch: Simulate normal-source failure.
   6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
      a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
      b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
   8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

H. Final connections to equipment shall be made with liquid tight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing equipment, test for compliance with requirements according to NETA ATS.
   2. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify that the unit is clean.

e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
f. Verify that manual transfer warnings are attached and visible.
g. Verify tightness of all control connections.
h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
   1) Use of low-resistance ohmmeter.
   2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
i. Perform manual transfer operation.
j. Verify positive mechanical interlocking between normal and alternate sources.
k. Perform visual and mechanical inspection of surge arresters.
l. Inspect control power transformers.
   1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
   2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
   3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:
   a. Perform insulation-resistance tests on all control wiring with respect to ground.
   b. Verify settings and operation of control devices.
   c. Calibrate and set all relays and timers.
   d. Verify phase rotation, phasing, and synchronized operation.
   e. Perform automatic transfer tests.
   f. Verify correct operation and timing of the following functions:
      1) Normal source voltage-sensing and frequency-sensing relays.
      2) Engine start sequence.
      3) Time delay on transfer.
      4) Alternative source voltage-sensing and frequency-sensing relays.
      5) Automatic transfer operation.
      6) Interlocks and limit switch function.
      7) Time delay and retransfer on normal power restoration.
      8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.
5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
   a. Verify grounding connections and locations and ratings of sensors.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Transfer switches will be considered defective if they do not pass tests and inspections.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

END OF SECTION 263600

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SECTION 265119 - LED INTERIOR LIGHTING

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 the following types of LED luminaires:
   1. Lowbay.
   2. Suspended, linear.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
   6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
      a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Ambient Temperature: 41 to 104 deg F.
   1. Relative Humidity: Zero to 100 percent.

B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles.
   1. Label shall include the following lamp characteristics:

2.3 LINEAR INDUSTRIAL.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Lighting, an Eaton business.
   2. GE Lighting Solutions.
   3. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Lamp:
   1. Minimum 5,000 lm.
   2. Minimum allowable efficacy of 80 lm/W.
   3. CRI of minimum 65. CCT of 3000 K.
   4. Rated lamp life of 35,000 hours to L70.
   5. Dimmable from 100 percent to 0 percent of maximum light output.
   6. Internal driver.
   7. User-Replaceable Lamps:
      a. Bulb shape complying with ANSI C78.79.

b. Lamp base complying with ANSI C81.61.

8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:
1. Extruded-aluminum housing and heat sink.
2. Clear finish.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:
1. Tempered Fresnel glass.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. With integral mounting provisions.

G. Standards:
1. ENERGY STAR certified.
2. RoHS compliant.

2.4 LOWBAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Lighting, an Eaton business.
2. GE Lighting Solutions.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.

B. Nominal Operating Voltage: 120 V ac.

C. Lamp:
1. Minimum 5,000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 65. CCT of 3000 K.
4. Rated lamp life of 35,000hours to L70.
5. Dimmable from 100 percent to 0 percent of maximum light output.
6. Internal driver.
7. User-Replaceable Lamps:
a. Bulb shape complying with ANSI C78.79.
b. Lamp base complying with ANSI C81.61.
8. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

D. Housings:
1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:
1. Tempered Fresnel glass.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. Standards:
1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - 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 luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Engineer, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:
   1. Sized and rated for luminaire weight.
   2. Able to maintain luminaire position after cleaning and relamping.
   3. Provide support for luminaire without causing deflection of ceiling or wall.
   4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Suspended Luminaires:
   1. Ceiling Mount:
      a. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 10 feet in length.
   2. Pendants and Rods: Provide accessories as shown on the Drawing to allow swinging of luminaires.
   3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
   4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
   1. During adjustment visits, inspect all luminaires. Replace drivers or luminaires that are defective.
   2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   3. Adjust the aim of luminaires in the presence of the Engineer or Engineer

END OF SECTION 265119

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SECTION 271523 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

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. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
   2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
   3. Grounding.
   4. Cabling identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system shall provide interconnections between the new chemical building and the existing CS-2 building. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of product.

B. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

1. None.

1.9 QUALITY ASSURANCE

A. The cable manufacturer shall be ISO 9001 certified and registered.

B. The fiber optic cabling system materials furnished under this Section shall be provided by Fiber Optic Suppliers who have been providing these types of materials for the past three years. The Fiber Optic Suppliers shall provide personnel capable of providing technical assistance during installation.

C. The installation of fiber optic cabling system materials furnished under this Section shall be performed by an installation Contractor who has been installing these types of materials and systems for the past three years.

D. Supplier shall furnish five working installation references.

E. The Engineer shall determine whether a product is an equal based upon the information listed herein and the manufacturer's data sheets regarding the models specified. Alternate equipment shall meet the criteria listed herein and all additional information in the manufacturer's data sheets in order to be accepted as an equal.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining

ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, tight buffer, optical fiber cable.
1. American Technology Systems Industries, Inc.
2. Corning Cable Systems.
3. Or Equal.

B. Standards:
1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

D. Patch Cords: Factory-made, single-fiber cables in 36-inch (900-mm) lengths.

E. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

F. Plugs and Plug Assemblies:
1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:
1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Patch panel shall be suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors, and ground lugs. Panels shall be NEMA 4X, Type 316 stainless steel construction for outdoors; and NEMA 12, Type 316 stainless steel or fiberglass for indoor use. The patch panel shall be sized to handle 6 connections. All fibers shall be terminated in the patch panel.

B. Panels shall be as manufactured by Corning Cable Systems LANscape or equal.

2.4 Fiber cable connectors

A. The fiber optic communications system shall utilize stainless steel ST style connectors for all fiber optic connections. SC style connectors will be acceptable only if ST style connectors are not compatible with the equipment being provided. The connectors shall be designed for use with 50/62.5/125/250 micron cable. Each connector shall cause a maximum signal attenuation of 1.6 dB.

B. Field-Installed Connectors: Type ST compatible, SC or LC design with ceramic or polymer ferrule and strain relief boot. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 µm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall contain a mechanical splice and have a tool kit available to aid in assembly. The installation tools used to terminate the connector shall be able to terminate other small-form-factor and single-fiber UniCam connector designs. The connector shall not require end-face polishing in the field. The connector shall have a factory polished optical fiber stub in the connector ferrule that is bonded in the ferrule micro hole. Ferrule material shall be available in ceramic or polymer. Connector specifications shall be as follows:
1. Insertion loss (typical): 0.3 dB
2. Durability (mating cycles): 500 (minimum)
3. Repeatability: Less than 0.2 dB
4. Operating Temperature: 0 to plus 60 degrees C

C. After termination with connectors, the fiber ends shall be visually inspected at a magnification of not less than 100 power for multimode and 200x for single mode to check for cracks or pits in the end face of the fiber.

D. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; dry interfaces only.

E. Each connector shall be of the industry standard ST type compatible; designed for single-mode and multimode tolerances; shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34; and shall be capable of 100 repeated ratings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a Zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials such as nickel-plated zinc, designed to operate in humid environments without degradation of surface finishes. Connectors shall be capable of operating in a range of -40 to 80 degrees C.

F. Manufacturers

1. Corning Cable Systems, Hickory, NC
2. AMP, Inc., Harrisburg, PA
3. 3M Telecom Systems Group, Austin, TX
4. Or equal.

2.5 FIBER OPTIC PATCH CABLES

A. Fiber optic patch cable shall be two-fiber zipcord 50/62.5/125 core/clad micron multimode riser rated cable.

B. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
   1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
   4. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

C. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:
   1. Flexible vinyl or polyester that flexes as cables are bent.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

B. Tests and Inspections:
   1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Optical Fiber Cable Tests:
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Link End-to-End Attenuation Tests:
         1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
         2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271523

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SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

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. Furnish all labor, equipment, materials and testing in connection with the installation of the Fire Alarm System as shown on the Drawings and as specified herein.

B. Employ the services of a licensed fire alarm protection systems engineering company to design and the fire alarm protection system and prepare detailed installation drawings and material specifications, to be signed and sealed by a professional engineer registered in the state where the project is located. These Contract Documents shall be submitted for review in accordance with Section 013000.

C. The fire alarm protection system shall be checked by the Authority Having Jurisdiction during design and upon completion of the installation. Assume full responsibility for the correctness of the installation and make all corrections and additions deemed necessary by the fire authority. Pay for all costs of the inspection and any subsequent re-inspections as required.

D. Design, furnish, install, test and place in operating condition an electronically-operated, double-supervised, closed-circuit fire alarm system. All units of equipment shall be listed by UL for fire alarm signaling use and shall consist of control panels, manual fire boxes, alarm initiating devices, alarm notification appliances, system devices, standby battery and charger and supervisory switches, all located as required by the system designer and applicable codes and wired in accordance with the manufacturer's instructions to make a complete and workable system.

E. System designer shall coordinate with the Authority Having Jurisdiction to assure that all Federal State and local requirements are met.

F. The fire alarm system design shall provide total coverage for the Chemical Building and shall be in accordance with the applicable local building codes and the Americans with Disabilities Act (ADA). Where the local codes are silent on an issue, the design shall be in accordance with NFPA 101. The application, installation, performance and maintenance of the fire alarm system and its components shall be in accordance with NFPA 72.

G. The design and installation of all wiring, cable and equipment shall be in accordance with NFPA 70, and specifically with Article 760, Article 770 and Article 800.

H. Provide all the documentation indicated in NFPA 72, Sections 1-7 and 7-5.2. The documentation and permanent records shall include but not be limited to written statement by the Contractor indicating the system has been installed and tested in accordance with applicable

documents; certificate of completion; installation instructions and after successful completion of acceptable test satisfactory to the Authority Having Jurisdiction; a set of reproducible as-built installation drawings; operation and maintenance manuals and a written sequence of operation.

I. Section Includes:
   1. Fire-alarm control panel.
   2. Manual fire-alarm boxes.
   3. Non-system smoke detectors.

J. Related Requirements:
   1. Section 260523 “Control-Voltage Electrical Power Cables” for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. FACP: Fire Alarm Control Panel.

B. HLI: High Level Interface.

C. NICET: National Institute for Certification in Engineering Technologies.

D. PC: Personal computer.

E. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.
   1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
   2. Include plans, elevations, sections, details, and attachments to other work.
   3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
   4. Detail assembly and support requirements.
   5. Include voltage drop calculations for notification-appliance circuits.
   6. Include battery-size calculations.
   7. Include input/output matrix.
   8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
   9. Include performance parameters and installation details for each detector.
   10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.

C. General Submittal Requirements:
1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Engineer.
2. Shop Drawings shall be prepared by persons with the following qualifications:
a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; Level III minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
   1) Equipment tested.
   2) Frequency of testing of installed components.
   3) Frequency of inspection of installed components.
   4) Requirements and recommendations related to results of maintenance.
   5) Manufacturer's user training manuals.
i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control panel and each annunciator unit.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
   3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
   4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
   5. Keys and Tools: One extra set for access to locked or tamper-proofed components.
   6. Audible and Visual Notification Appliances: One of each type installed.
   7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.9 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.10 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components:
   1. Components compatible with, and operate as an extension of, existing system.
   2. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
1. Manual stations.
2. Smoke detectors.
3. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control panel, connected network control panels, off-premises network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Activate voice/alarm communication system.
5. Activate emergency lighting control.
6. Record events in the system memory.
7. Indicate device in alarm on the graphic annunciator.

C. Provide supervisory signal initiation by one or more of the following devices and actions:
1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Independent fire-detection and -suppression systems.
5. User disabling of zones or individual devices.
6. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control panel.
5. Ground or a single break in internal circuits of fire-alarm control panel.
6. Abnormal ac voltage at fire-alarm control panel.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control panel or annunciator.
10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:
1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control panel, connected network control panels, off-premises network control panels,.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.

6. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL PANEL (FACP)

A. Manufacturers: Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fire-Lite Alarms, Inc.; a Honeywell International company.
   2. GE UTC Fire & Security; A United Technologies Company.
   3. Siemens Industry, Inc.; Fire Safety Division.
   4. SimplexGrinnell LP.

B. General Requirements:
   1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
      a. System software and programs be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
      b. Include a real-time clock for time annotation of events on the event recorder and printer.
      c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
      d. The FACP listed for connection to a central-station signaling system service.
      e. Provide nonvolatile memory for system database, logic, and operating system and event history.
      f. The system to require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
   2. Addressable Initiation Device Circuits: The FACP should:
      a. indicate which communication zones have been silenced
      b. provide selective silencing of alarm notification appliance by building communication zone.
   3. FACP for Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
   1. Pathway Class Designations: NFPA 72, Class A.
   2. Pathway Survivability: Level 0.
   3. Install no more than 50 addressable devices on each signaling-line circuit.
   4. Serial Interfaces:
      a. One dedicated RS 485 port for central-station operation using point ID DACT.
      b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
      c. One USB port for PC configuration.

d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

E. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control panel.
2. Activate an approved "alarm-verification" sequence at fire-alarm control panel and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control panel indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit:
1. Audible appliances sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal to be:
a. a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances: flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control panel.
1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control panel.
2. Status Annunciator: Indicate the status of various voice/alarm speaker zones
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

I. POWER SUPPLIES
1. Control panels shall receive 120 VAC power via a dedicated circuit breaker disconnect as indicated on the Drawings.
2. Provide 24 VDC power-limited power supplies as required for control panels or remote devices. Power supplies shall be backed up by a standby battery source capable of providing the connected system operating and supervisory current for 72 hours followed by 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby battery upon loss of normal 120 VAC input power, or upon detection of brownout, short circuit, over voltage, or a trouble condition in the power

supply. The system shall re-transfer back to the power supply upon normalization of this source.

3. Batteries shall meet the following criteria:
   a. Provide lead acid wet cell type batteries utilizing the recombination principle.
   b. Operating pressure shall be less than 4 psi. Cells operating at higher pressure are not acceptable.
   c. Battery lids shall be of flame-retardant plastic ABS type and shall be heat sealed to thick wall ABS container.
   d. Gel type or sealed top wet batteries shall not be allowed for safety and charge life considerations. Battery posts shall incorporate brass inserts for maximum conductivity. The battery shall be capable of withstanding its own short circuit current for a minimum of one minute.
   e. In the event of accidental cell case cracking, the battery shall be capable of maintaining the electrical circuit.
   f. When installed, the battery shall have all connections covered and insulated, to prevent accidental shorting.
   g. Provide automatic battery charging equipment to supervise battery condition and maintain full capacity at all times.
   h. Mount batteries in each control panel enclosure where possible. Provide a separate battery console type enclosure where size exceeds the capacity of the control enclosure.

J. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 PREACTION SYSTEM

A. Initiate Pre-signal Alarm: This function shall cause an audible and visual alarm and indication to be provided at the FACP. Activation of an initiation device connected as part of a pre-action system shall be annunciated at the FACP only, without activation of the general evacuation alarm.

2.5 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fire-Lite Alarms, Inc.; a Honeywell International company.
   2. Notifier.
   3. Siemens Industry, Inc.; Fire Safety Division.
   4. SimplexGrinnell LP.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control panel.
2. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Fire-Lite Alarms, Inc.; a Honeywell International company.
   2. Notifier.
   3. Siemens Industry, Inc.; Fire Safety Division.
   4. SimplexGrinnell LP.

B. General Requirements for System Smoke Detectors:
   1. Comply with UL 268; operating at 24-V dc, nominal.
   2. Detectors shall be four-wire type.
   3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control panel.
   4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
   5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
   6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
   7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control panel for calibration, sensitivity, and alarm condition
      a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control panel for 15 or 20 deg F per minute.
      b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control panel to operate at 135 or 155 deg F.
      c. Multiple levels of detection sensitivity for each sensor.
      d. Sensitivity levels based on time of day.

C. Ionization Smoke Detector:
   1. Detector address shall be accessible from fire-alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control panel, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

2.7 NOTIFICATION APPLIANCES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Mircom Technologies, Ltd.
   2. Siemens Industry, Inc.; Fire Safety Division.
   3. SimplexGrinnell LP.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Horns:
   1. Electric-vibrating-polarized type, 24-V dc;
   2. provision for housing the operating mechanism behind a grille.
   3. Comply with UL 464.
   4. sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.
   6. Mounting Faceplate: Factory finished, red.

E. Voice/Tone Notification Appliances:
   1. Comply with UL 1480.
   2. Mounting: surface mounted and bidirectional.
   3. Matching Transformers: Tap range matched to acoustical environment of speaker location.

F. Exit Marking Audible Notification Appliance:
   1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
   2. Provide exit marking audible notification appliances at the entrance to all building exits.
   3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.8 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. An alarm condition shall be automatically transmitted to the Remote Supervising Station via Digital Alarm Communicator Transmitter (DACT) connected to two separate means of transmission at the protected premises. Furnish and install equipment as required by the AHJ. The DACT shall be capable of selecting the operable means of transmission in the event of failure of the other. The primary means of transmission shall be a cellular line (number) connected to the public switched network in combination with one of the following secondary transmission channels:
   1. A cellular telephone connection.

C. Functional Performance:
   1. An alarm, supervisory, or trouble signal from fire-alarm control panel and automatically capture two cellular lines and dial a preset number for a remote central station.
   2. When contact is made with central station(s), signals to be transmitted.
   3. If service on either line is interrupted for longer than 45 seconds:
      a. initiate a local trouble signal and transmit the signal indicating loss of cellular line to the remote alarm receiving station over the remaining line
      b. automatically report cellular service restoration to the central station.
      c. If service is lost on both cellular lines, initiate the local trouble signal.

D. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both cellular lines are available.
   2. Programming device.
   3. LED display.
   4. Manual test report function and manual transmission clear indication.
   5. Communications failure with the central station or fire-alarm control panel.

E. Digital data transmission shall include the following:
   1. Address of the alarm-initiating device.
   2. Address of the supervisory signal.
   3. Address of the trouble-initiating device.
   4. Loss of ac supply.
   5. Loss of power.
   6. Low battery.
   7. Abnormal test signal.
   8. Communication bus failure.

F. Secondary Power: Integral rechargeable battery and automatic charger.

G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
   1. Devices placed in service before all other trades have completed cleanup shall be replaced.
   2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   1. Connect new equipment to existing control panel in existing part of the building.
   2. Connect new equipment to existing monitoring equipment at the supervising station.
   3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Manual Fire-Alarm Boxes:
   1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
   2. Mount manual fire-alarm box on a background of a contrasting color.
   3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

E. Smoke-Detector Spacing:
   1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
   2. Smooth ceiling spacing shall not exceed 30 feet.

3. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex Ain NFPA 72.
4. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
5. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

F. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

B. Install framed instructions in a location visible from fire-alarm control panel.

3.4 GROUNDING

A. Ground fire-alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control panel.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

C. Fire-alarm system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

F. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
   1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
   3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 284621.11

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SECTION 310515 - SOILS AND AGGREGATES FOR EARTHWORK

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. Soils: Soil materials and topsoil materials.
   2. Aggregates: Coarse aggregate materials and fine aggregate materials.

B. Related Sections:
   1. Section 312000 “Earthwork.”
   2. Section 312333 “Trenching and Backfilling”
   3. Section 312500 “Erosion and Sedimentation Control.”
   4. Section 321123 “Aggregate Base Courses.”
   5. Section 329219 “Seeding.”
   6. Section 331116 “Site Water Utility Distribution Piping.”
   7. Section 333100 “Sanitary Sewerage Piping.”
   8. Section 335100 “Natural-Gas Distribution.”

1.3 ACTION SUBMITTALS

A. Section 013300 “Submittal Procedures” for requirements of submittals.

B. Samples - Soils: Submit in 5-gallon air-tight containers, 50 lbs. sample of each type of fill to testing laboratory.

C. Samples - Aggregates: Submit, in 5-gallon air-tight containers, 50 lbs. sample of each type of aggregate fill to ENGINEER at least 15 days prior to placement of backfill or fill.

D. Quality Control Testing: Submit conformance testing performed by a certified independent laboratory engaged by Contractor for all fill materials. Verify maximum density, gradation, Atterberg limits, sand equivalent, and other applicable criteria at least 72 hours prior to importing or placing any fill. Perform additional conformance testing at a minimum frequency of 1 per every 2000 cubic yards or change in material.

1.4 INFORMATIONAL SUBMITTALS

A. Materials Source: Submit name and location of imported materials suppliers.

B. Source’s Certificate: Certify materials meet or exceed specified requirements.

C. Material Test Reports: For each on-site and borrow soil and aggregate material proposed for fill and backfill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 1557.
   3. Test Reports: Submit any test reports required by this Section to the Engineer.

1.5 QUALITY ASSURANCE

A. Furnish each subsoil and topsoil material from single source throughout the Work, unless an alternate source is approved by the Engineer.

B. Furnish each coarse and fine aggregate material from single source throughout the Work, unless an alternate source is approved by the Engineer.

C. Perform Work according to State of Michigan Department of Transportation standards.

D. Quality Control and Quality Assurance consists of laboratory conformance testing of samples supplied from each coarse and fine aggregate source and quality control during installation.
   1. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

E. Maintain one copy of each standard affecting Work of this Section on Site.

1.6 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Common Fill - Common fill shall be approved on site excavated material or imported fill material that is composed of durable soil free of debris, organic matter, or other deleterious materials. Common fill shall not contain stones larger than 6 inches in largest diameter, a maximum of 75 percent passing the No. 200 sieve, and a maximum dry density of at least 85 pounds per cubic foot (pcf) as determined by ASTM D 1557. Common fill shall not contain granite blocks, broken concrete, masonry rubble, or other similar materials and shall have physical properties such that it can be readily spread and compacted during filling.

B. Select Common Fill – Select common fill shall be as specified above for common fill except that the material shall contain no stones larger than 2 inches in largest diameter.

C. Structural Fill – Structural fill shall consist of MDOT 21AA Limestone compacted to at least 95 pcf as determined by ASTM D1557.

2.2 COARSE AGGREGATE MATERIALS

A. Coarse Aggregate – Clean Crushed Stone: Natural stone; washed, free of clay, shale, organic matter; 1" X 3" limestone with no fines.

B. Coarse Aggregate - Crushed Stone: Natural stone; washed, free of clay, shale, organic matter; conforming to MDOT 21 AA standard conforming to all the requirements of Michigan Department of Transportation (M•DOT) "2012 Standard Specifications for Construction", section 902

C. Coarse Aggregate - Screened Gravel: Natural stone; washed, hard, durable, rounded, or sub-angular particles of proper size and gradation, and shall be free from sand, loam, clay, excess fines, and other deleterious materials; MDOT 6A Standard conforming to all the requirements of Michigan Department of Transportation (M•DOT) "2012 Standard Specifications for Construction", section 902

2.3 FINE AGGREGATE MATERIALS

A. Fine Aggregate - Sand: Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter; graded according to; MDOT 2NS Natural Sand conforming to all the requirements of Michigan Department of Transportation (M•DOT) "2012 Standard Specifications for Construction", section 902

B. Fine Aggregate bank run sand. MDOT Class II Sand conforming to all the requirements of Michigan Department of Transportation (M•DOT) "2012 Standard Specifications for Construction", section 902

2.4 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing and inspection services. Submit test result reports to the Engineer.

B. Subsoil Material - Testing and Analysis: Perform in accordance with ASTM D 1557.

C. Topsoil Material - Testing and Analysis: Perform in accordance with ASTM D 1557.

D. Coarse Aggregate Material - Testing and Analysis: Perform according to ASTM D 1557.

E. Fine Aggregate Material - Testing and Analysis: Perform according to ASTM D 1557.

F. When tests indicate materials do not meet specified requirements, change material and retest.

G. Furnish materials of each type from same source throughout the Work.

PART 3 - EXECUTION

3.1 EXCAVATION - SOILS

A. Excavate subsoil and topsoil from areas designated. Strip topsoil to full depth of topsoil in designated areas.

B. Stockpile excavated material meeting requirements for subsoil materials and topsoil materials.

C. Remove unsuitable materials not intended for reuse, and all unused materials from the site. All materials removed from the site shall become the property of the contractor and shall be disposed of in accordance with all applicable state and local regulations.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different soil and aggregate materials with dividers or stockpile individually to prevent mixing. Prevent intermixing of soil types or contamination.

D. Stockpile topsoil 8 feet high maximum.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION 310515

SECTION 310900 - GEOTECHNICAL INSTRUMENTATION AND MONITORING

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 performing pre-construction surveys and installing and monitoring geotechnical instrumentation and survey markers to measure.
   1. Performance of excavation support systems.
   2. Groundwater levels inside and outside excavation limits.
   3. Vertical deformation of ground surface adjacent to and directly over the Work.
   4. Vertical and horizontal deformation of existing utilities and structures adjacent to and over the Work.
   5. Ground vibration levels at adjacent facilities due to Contractor activities, including but not limited to demolition, pile installation, blasting, and rock excavation.

B. Related Requirements:
   1. Section 312000 "Earthwork" for earthwork materials and operations.
   2. Section 312319 "Dewatering" for dewatering and drainage.
   3. Section 312333 “Trenching and Backfilling” for those procedures.
   4. Section 315000 "Excavation Support and Protection" for temporary procedures.

1.3 DEFINITIONS

A. Crack Gauges: Transducers mounted across cracks identified on existing structures during the preconstruction survey to monitor the crack width.

B. Deformation Monitoring Points (DMPs): Fixed markers placed on existing utilities and structures to measure both vertical and horizontal movement. Initial coordinate locations and vertical controls are determined by optical survey methods.

C. Excavation Support Monitoring Points (ESMPs): Inscribed marking or fixed makers placed on excavation support systems to measure horizontal movement of the excavation support system.

D. Groundwater Observation Wells: Screened or slotted pipe with solid riser pipe installed in a drilled hole with the annulus around the pipe backfilled with sand. Near surface groundwater levels are measured in the well.

E. Seismographs: Electronic recording device with vibration transducer capable of monitoring and recording ground vibrations induced by construction activity.

F. Surface Monitoring Points (SMPs): Inscribed marking or approved surveyor's nail installed to measure vertical (elevation) movement.

G. Utility Monitoring Points (UMPs): Steel rod inside fully cased hole that is resting on existing utilities or underground structures to measure movement of the existing underground structure or utility.

1.4 ACTION SUBMITTALS

A. Submit in accordance with Section 013300.

B. Submit for the Engineer’s review four weeks prior to instrument installation:
   1. Installation Plan and Schedule: Full details and plan/layout of proposed instruments/points, schedule for installing and monitoring instruments/points, equipment types, installation methods, reference points, and monitoring and data reporting schedule for instruments/points, and instrumentation protection.
   2. Description of methods for installing and protecting all instrumentation including but not limited to seismographs, observation wells, crack gauges, monitoring points, and reference points.
   3. Groundwater observation well construction details including casing type, filter gradation, screen interval, grout mix, drilling methods, and well depths.
   4. For instrumentation installed in borings, submit a detailed procedure for installation, including post-installation acceptance test, together with a sample installation record sheet that include:
      a. Method to be used for cleaning inside of casing or augers.
      b. Drill casing or auger type and size.
      c. Depth increments for backfilling boreholes with sand and bentonite.
      d. Method for overcoming buoyancy of instrumentation components during grouting.
      e. Method of sealing joints in pipe casing to prevent ingress of grout.

C. Installations Records: Within five working days of installing each instrument, submit to the Engineer, specified as-built instrument location and its corresponding installation record sheet.
   1. Include in installation record sheet, location with instrument identification numbers, established elevations, initial elevations and coordinates (baseline readings), boring log, installation, and monitoring date and time.
   2. Furnish details of installed instruments showing dimensions, materials used, and as-built drawings of each instrument.
   3. Submit field calibrations.

D. Reports and Records: Provide reports of monitoring data to the Engineer. include following minimum information:
   1. Preconstruction survey.
   2. As-installed location plan, installation records, and baseline values for instrumentation.
   3. Monitoring data for instruments with plots against threshold values.
   4. Weekly records of crack monitors and including photographs with readings.
   5. Event reports and summary from vibration monitoring.
   6. Discussion and associated action related to results exceeding threshold values.

E. Submit proposed remedial measures to the Engineer of action to be taken in event that instrument Threshold Values are reached.

1.5 INFORMATIONAL SUBMITTALS

A. Submit names, qualifications, and experience of personnel who will install instruments, perform optical level survey and vibration monitoring, read instruments, and report data to the Engineer demonstrating compliance with “Quality Assurance” Article in this Section.

B. Certificates: Submit for each seismograph or other necessary instrument that manufacturer has inspected and tested each instrument before it leaves the factory confirming that it is working correctly without defects or missing parts and current calibration records.

1.6 QUALITY ASSURANCE

A. Geotechnical Instrumentation Engineer Qualifications: Professional engineer registered in the State of Michigan with at least 5 years’ experience in installation of specified instrumentation and will supervise and direct technicians and be responsible for instrument installation. Be present at installation sites to direct and supervise installations, oversee instrumentation reading, and supervise geotechnical instrumentation data interpretations.

B. Surveyor Qualifications: Professional Land Surveyor registered the State of Michigan with at least 3 years’ experience in surveying of similar instruments. Establish Deformation Monitoring Points, Surface Monitoring Points, Utility Monitoring Points, and Excavation Support Monitoring Points and take baseline readings.

C. Manufacturer Qualifications: Provide instruments and components from an approved manufacturer currently engaged in manufacturing specified geotechnical instrumentation hardware.

D. Preconstruction Survey Engineer Qualifications: Professional engineer registered in the State of Michigan with at least 5 years’ experience in structural evaluations and condition surveys.

E. Monitoring Technicians Qualifications: Minimum 3 years’ experience for personnel responsible for optical level surveys, instrument readings, and report data.

F. Vibration Monitoring Qualifications: Persons trained in use of a seismograph along with reporting results of analyzing and reporting frequency content of a seismograph record.

G. Instrument Installation Technicians: Experienced in installation and reading of specified geotechnical instrumentation and equipment.

H. Factory Calibration: Conduct factory calibration on instruments prior to shipment with certification submitted to indicate that test equipment used for this purpose is calibrated and maintained in accordance with test equipment manufacturer's calibration requirements and that, where applicable, calibrations are traceable to U.S. National Institute of Standards and Technology.
   1. Include a calibration curve with data points clearly indicated and a tabulation of data. Mark each instrument with a unique identification number.

I. Perform instrument installations in presence of the Engineer.

J. Be responsible for installation, maintenance, and monitoring of geotechnical instrumentation.

PART 2 - PRODUCTS

2.1 DESIGN AND PERFORMANCE REQUIREMENTS

A. Project Requirements:
1. Install geotechnical instrumentation to monitor ground conditions, ground response, and facilities to achieve specified project requirements and prevent damage to facilities potentially affected.
2. Install instrumentation in accordance with approved Instrumentation Schedule.
3. Engineer's monitoring of installed instruments does not relieve Contractor of its obligation to complete project within the requirements specified herein taking necessary additional measurements.

B. Pre-Construction Survey:
1. Prior to start of demolition, excavation work, installation of excavation support and dewatering work, engage the services of an independent licensed professional engineer, to conduct a pre-construction survey of existing structures and conditions within 100 feet of the anticipated demolition, excavation work, installation of excavation support, and dewatering work.
   a. Coordinate activities, issue notices, obtain clearances and provide photographic and secretarial assistance necessary to accomplish the survey.
   b. Give notice in writing, to property owners and representatives of local authorities required to be present at such survey. Notify in writing the dates on which surveys are planned so that representatives are present during the examination. Provide copies of notices to Owner and the Engineer
2. Record observations of the existing conditions for residences, buildings and other structures, which are affected.
   a. Provide the survey consisting of a description of interior and exterior conditions. Locate cracks, damage or other defects existing and include information to make it possible to determine the effect, if any, of the construction operations on the defect. Where significant cracks or damage exists, or for defects too complicated to describe in words, photographs shall be taken and made part of the record.
   b. Records of each property examined must be signed by the representatives present and, if practicable, by property owners, whether or not they are present at the examinations.
3. Record of the pre-construction survey shall consist of written documentation, video and photographs of the conditions identified. At the completion of the survey, submit copies of the documentation to Owner.
4. Upon completion of all excavation work, installation of excavation support and dewatering work, the complete a similar examination of properties and structures where complaints of damage have been received or damage claims have been filed. Give notice to interested parties so that they may be present during the final examinations. Records of the final examination shall be signed and distributed as the original pre-construction survey.
5. Retain records in Contractor's file for at least 3 years after completion of the Contract. In the event of damage claims, prepare a report on the particular structures as requested by the Engineer from those notes and photographs and submitted to Owner. Repair damage attributed to Contractor’s activity promptly and completely to property owners’ satisfaction to restore the conditions of the property to that existing prior to work.

C. Secure required permits prior to the installation or removal of observation wells.

D. Provide and facilitate safe access to the instruments at all times. Engineer may perform additional monitoring in a manner that will minimize unnecessary work delays. Allow and facilitate instrument monitoring as required by the Engineer. No claim for lost production time due to this activity will be allowed.

E. Maintain instrumentation. Report damaged or non-functional instrumentation to the Engineer within 24 hours. Replace damaged instruments within 24 hours.

F. Availability of Data:
1. Instrumentation readings shall be collected by the Contractor's Geotechnical Instrumentation Monitoring Firm. Contractor may take their own supplementary readings in addition to those specified.
2. Monitoring data is the property of Owner and is not to be disclosed or published to third parties without Owner's written permission.
3. Contractor is expected to make their own interpretations for their own purposes without additional compensation.
4. Coordinate with the Engineer to verify consistency of collected data.

2.2 INSTRUMENTATION - GENERAL

A. Instruments and materials, including readout units, installation tools, materials, and miscellaneous instrumentation components.

B. Provide surface protection for instruments flush with surface in paved or other ground surface areas at the time that work is completed.

C. Minimum Quantity of Instruments: While quantities in following Paragraph are considered minimums, obtain data from instrumentation in quantity to monitor construction, performance, and safety aspects of the Work.

D. Following subparagraphs identify instrument type, minimum number to be provided, and approximate installed depth from below bottom of excavation / tunnel invert:

	Instrument Type:	Number:	Depth:
1.	Observation Wells:	2	10 feet
2.	Seismographs:	2	N/A.
3.	Surface Monitoring Points:	2	N/A.
4.	Utility Monitoring Points:	2	N/A.
5.	Excavation Support Monitoring Points:	As Needed	N/A.

E. Locate instruments and obtain approval from the Engineer.

2.3 GROUNDWATER OBSERVATION WELLS

A. Pipe: ASTM D 1785, Schedule 40 PVC pipe, 1-inchminimum inside diameter.

B. Maximum Screen Size: 0.020 inch, unless otherwise approved by the Engineer.

C. Use observation wells to monitor groundwater levels outside excavations.

2.4 MONITORING POINTS

A. Surface Monitoring Points (SMPs):
   1. Use to monitor vertical deformation at or near ground surface, clearly identifying points with permanent easily readable letters and numbers as approved by the Engineer.
   2. Paved Areas: 2 inches long masonry nail, manufactured from hardened zinc–plated steel and driven into an asphalt covered surface. Identify each nail individually with an identification tag or surface marking.
   3. Non-Paved Areas: 3 feet 3/4-inch diameter steel rod driven into ground or set in concrete such that no more than 3 inches of rod is exposed above ground surface. Round top of rod and punch-mark it at its center. Identify each rod with a surface marking.
   4. Utility Manholes: Observable cross mark or welded bead on top horizontal surface of manhole rim. Clean surface within 3 inches of point and mark it using fluorescent spray paint adjacent to point to permit easy identification of exact location.

B. Deformation Monitoring Points (DMPs):
   1. Use to monitor vertical and horizontal movement of adjacent utilities and structures with following approved by the Engineer.
   2. Materials: Nails, screws, reinforcing bars, bolts, and similar materials with well-defined measurement points.
   3. Firmly attach and protect from damage and vandalism. Remove or cover points protruding more than 1/4 inch with a protective box or cap.
   4. Clearly identify with permanent easily readable letters and numbers.

C. Utility Monitoring Points (UMPs):
   1. Use to monitor vertical and horizontal deformation of selected utilities and underground structures. Include following at a minimum:
      a. Steel Pipe: ASTM A 53/A 53M Grade B, 3-1/2 inch extra strong steel sleeve and 1 inch extra strong steel riser, threaded and coupled.
      b. PVC Centralizers: ASTM D 1785, Schedule 40 PVC pipe, sized to provide a tight fit on riser pipe, and spring-formed to a larger diameter to provide a loose fit in sleeve pipe.
   2. Install to top of utility or underground structure by vacuum excavation method. Set monitoring rod with centralizers on top of the utility or underground structure and extending to within 1 foot of ground surface.
   3. Install with a flush mount road box casing at grade, clearly identified by surface marking.

D. Excavation Support Monitoring Points (ESMPs):
   1. Use as fixed markers on vertical elements of excavation support system and to monitor horizontal deformation of excavation support system designed by Contractor.
   2. Clearly identified points with permanent easily readable letters and numbers as approved by the Engineer.
   3. Clean surface within 3 inches of each point and clearly identify using fluorescent spray paint adjacent to point.

E. Non-Shrink Cement Grout: Suitable for intended application.

2.5 SEISMOGRAPHS

A. Portable for monitoring ground vibrations velocities resulting from construction activities, calibrated within the previous six months, and having following characteristics:
   1. Measure three mutually perpendicular components of particle velocity in directions vertical, radial, and perpendicular to vibration source.
   2. Measure and display maximum peak particle velocity continuously during vibration-generating activities.
   3. Have a low frequency omnidirectional transducer for measuring air blast overpressure with a flat frequency response within the limits of 2 Hertz 200 Hertz (0.0002 Megahertz) with a tolerance equal to or better than plus or minus 10 percent.
   4. Seismic Range: 0.01 inch 4 inches (101.6 mm) per second with an accuracy of plus or minus 5 percent of measured peak particle velocity or better at frequencies between 10 Hertz and 100 Hertz, and with a resolution of 0.01 inch per second or less.
   5. Acoustic Range: 110 dBto 140 dB (referenced to 20 micro-Pascals) with an accuracy and resolution of plus or minus 1 dB.
   6. Frequency Response (plus or minus 3 dB: 2 Hertz 200 Hertz (0.0002 Megahertz).
   7. Two Power Sources: Internal rechargeable battery and charger capable of supplying power to monitor vibrations continuously for up to 24 hours at 115 volts AC.
   8. Self-triggering wave form capture mode that provides plot of wave forms, peak particle velocities, peak overpressure, and frequencies of peaks.
   9. Continuous monitoring mode capable of recording single-component peak particle velocities and frequency of peaks with an interval of 1 minute or less.

B. Provide for full-time use on the project during vibration causing construction activities.

2.6 CRACK MONITORS

A. Crack Gauges:
   1. Threaded Anchors: Include ball joints which can be grouted to each side of crack in any orientation.
   2. Transducer: Range of at least 1 inch and an accuracy of less than 0.1 percent and a non-linearity of no more than 0.5 percent.
   3. Gauge: Capable of operating in temperatures ranging from minus 68 degrees F 176 degrees F (80 degrees C).

B. Provide a solid steel cover over each gauge which does not touch or otherwise interfere with gage operation.

C. Basis-of-Design Manufacturer - Crack Gauges: Provide Model 4420 as manufactured by Geokon, Inc., or equal for monitoring width of existing cracks and joints.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Existing Conditions: Locate vaults, structures, conduits and underground utilities in areas where wells are to be drilled and installed. Conduct utility clearance and contact utility companies prior to any drilling.
   1. Modify instrument locations, as approved by the Engineer, to avoid interference with existing vaults, structures, conduits and utilities.
   2. Repair damage to existing facilities resulting from instrument installations without additional compensation.

B. Prior to commencing installation of, excavation support, excavation,,, and dewatering work, furnish instrumentation and related components that are to be installed during construction and conduct pre-construction surveys.

C. Protect from damage and maintain instruments. Repair or replace damaged instruments.

D. Drilling from Ground Surface: Obtain necessary permits for each instrument and conform to permit requirements during drilling and installation.

E. Implement remedial measures based on interpretations of monitoring data program.

3.3 GENERAL REQUIREMENTS

A. Perform a pre-construction survey prior to any dewatering, excavation, or installation of excavation support.

B. Install instruments at the Engineer approved locations in accordance with approved installation procedures. Engineer may modify instrument locations depending on field conditions and monitoring objectives. Install instrumentation in accordance with approved installation schedule. Install instruments and obtain baseline data before construction starts.

C. Allow the Engineer access to instrument locations and assistance required in obtaining monitoring data.

D. Clearly mark and label instruments and protected to avoid being obstructed or otherwise damaged by construction operations or general public. Immediately following installation, survey location and top of instruments to provide horizontal and vertical coordinates.
   1. Resurvey if the Engineer questions instrument locations

E. Assign a unique identification number to each instrument and each point that is clearly marked in a non-destructible manner.

F. Initial Reading: Immediately following instrument installation take two sets of initial readings in the Engineer's presence to provide baseline readings and to demonstrate adequacy of completed installation.

3.4 MONITORING POINTS

A. Monitoring Points: Include but not be limited to SMPs, DMPs, UMPs and ESMPs. Monitor these control points using surveying methods. Modify locations to meet site constraints with the Engineer's approval.

B. SMPs, DMPs and UMPs: Install as described below near excavations and and open trench locations. Additional SMPs, DMPs, and UMPs may be required by the Engineer.

C. Additional SMPs:
1. Install in pavement or ground surface within along each side of trench excavations that is within 35 feet of structures. Install at spacing not exceeding 50 feet.
2. Install on rim of utility manhole covers located within 50 feet of trenchless crossings or within 30 feet of open excavations.

D. DMPs:
1. Install on exterior walls of buildings or structures located within 30 feet of open excavations, 100 feet of pile installation, or 50 feet of shafts or trenchless crossing alignments. Preferred installations are on supporting walls or columns. Avoid installation in brick, unless no other option exists.
2. As a minimum, install on exterior wall corners of buildings, structures, or property boundary walls at not more than 50 feet spacing. Install additional DMPs to monitor building movement at other locations when determined by the Engineer.
3. Install DMPs in cooperation with property Owners so that installations are inconspicuous and acceptable to them. Existing features of building foundations that are permanent and can be repeatedly surveyed may be substituted for DMPs, if approved by the Engineer.

E. UMPs: Install on existing utility over 36 inch in diameter and located within 15 feet from excavation or directly over trenchless crossing. Locate at a spacing of not more than 50 feet.

F. ESMPs:
1. Install on excavation support systems other than trench box along support walls at spacing not more than 25 feet.
2. Install prior to excavation within exaction support system.
3. Read results at least daily during associated excavation and twice a week until backfill is completed.

G. SMPs, UMPs, and DMPs:
1. Obtain two sets of measurements for each monitoring point to establish baseline data within three days of installation. Make at least 24 hours apart, but not more than 48 hours.
2. Check monitoring points with initial surveyed elevations or offsets as appropriate differing by more than 0.08 inch for secure installation and resurvey.
3. Read monitoring points prior to installing excavation support, beginning, excavation, operation of groundwater control system, , or start of installation of excavation support at the site.
4. Read daily during, excavation, dewatering, filling and backfilling, and excavation support installation located within 50 feet of the work, then at least twice a week until excavation, dewatering, and backfill has been completed.

H. Crack Gauges:

1. Install on exterior walls of buildings or structures with existing cracks located within 30 feet of open excavations.
2. Install DMPs in accordance with manufacturer's recommendations and in cooperation with property Owners so that installations are inconspicuous and acceptable to them.

3.5 VIBRATION MONITORING

A. Take seismograph readings during and excavation support installation or other activities causing ground vibrations within 50 feet of existing structures to document that peak particle velocities do not exceed specified limit criteria.

B. Install seismographs near existing structures when vibratory or impact hammers are used for the installation of excavation support within 50 feet of existing structures, and as directed by the Engineer.

3.6 GROUNDWATER OBSERVATION WELLS

A. Install at least one monitoring well at site

B. Existing wells may be used if appropriate and approved by the Engineer.

C. Set screened interval of each well to monitor groundwater levels.

D. Drill 4 inch minimum diameter holes for observation wells of required size and depth and case with temporary casing. Do not use bentonite drilling mud in drilling holes for observation wells.

E. Flush cased holes with clean water through an approved bit. Flush until discharge water is free of soil particles.

F. Construct observation well with 10 feet of slotted PVC well screen, filter sand, bentonite seal, couplings, a pipe cap, and a locking cover.
   1. Place two feet of filter sand in bottom of drilled hole. Then place well screen and surround it with filter sand, as temporary casing is carefully withdrawn.
   2. Insert solid PVC casing and cap and fill annular space with bentonite pellets then non-shrink cement grout.
   3. Protect observation wells at ground surface by providing a roadway box or outer protective casing with lockable top and padlock. Design surface protection to prevent damage by vandalism or construction operations and to prevent surface water from infiltrating.
      a. Provide two keys for each padlock to the Engineer for access to each well.
      b. Develop observation wells to provide a reliable indication of groundwater levels. Re-developed wells if well clogging is observed, in event of apparent erroneous readings, or as directed by the Engineer.
      c. Submit observation well installation logs, top of casing elevation, and well locations to the Engineer within 24 hours of completion of well installation.

G. Observation Well Maintenance:

1. Maintain each observation well until adjacent structures, and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.
2. Maintain observation wells and repair or replace them without additional compensation, whether or not observation wells are damaged by Contractor's operations or by third parties.

H. Monitoring and Reporting of Observation Well Data:
1. Begin daily monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Continue daily monitoring in areas where groundwater control is in operation until time that adjacent structures, and pipelines are completed and backfilled and until time that groundwater control systems are turned off.
2. Be responsible for processing and reporting observation well data to the Engineer daily. Submit data to the Engineer on a form that includes following information.
   a. Observation well number.
   b. Depth to groundwater.
   c. Top of casing elevation.
   d. Groundwater level elevation.
   e. Date and time of reading.
   f. River

I. Following construction, abandon new observation wells as directed by the Engineer.
1. Abandon observation wells by removing materials within original borehole, including casing, filter, and grout seal in accordance with applicable permits.
2. Using approved tremie methods, completely fill hole and voids with non-shrink cement grout prior to removal of drill casing, such that formation materials do not move into hole prior to grouting.
3. Restore ground surface to its original condition.
4. Abandon wells within paved areas by removing vaults and well caps to pavement subgrade.
5. Remove wells with as discussed above and repair or patch pavement with same surface type.

3.7 INSTRUMENT PROTECTION, MAINTENANCE AND REPAIR

A. Protect instruments from damage. Replace damaged or destroyed instruments within 72 hours of damage, without additional compensation. If necessary, suspend work in areas being monitored by damaged instrument and take remedial action.

B. Maintain instruments by draining water and flushing debris from under protective covers and keeping covers locked and sealed at all times.

3.8 MONITORING

A. Collect, tabulate, plot, and interpret survey monitoring data and provide the Engineer with tabulated and plotted data. Report status of, excavation, bracing, groundwater levels,,, and backfilling at time of data collection with each report.

B. Monitoring frequency may be modified as directed and approved by the Engineer.

C. Submit data from readings of monitoring points to the Engineer within 24 hours of reading. Communicate verbally with the Engineer immediately after visual observations or data collection if excessive movements or other anomalies are indicated.

D. For seismograph data, submit a summary report with event summary of peak particle velocity and frequency. Submit a strip chart indicating time and magnitude of maximum single-component peak particle velocity measured during each 5-minute interval of monitoring period. List a summary of vibration producing activities for that week along with specific events causing anomalous readings.

E. Make visual observations of ground conditions and building conditions in site vicinity and communicate immediately with the Engineer if signs of ground or building movements are observed.

F. Engineer may take independent instrumentation measurements. Cooperate with the Engineer during instrumentation monitoring by providing access to instrumentation locations in a timely manner and by providing and maintaining safe means of access to instrumentation locations for data collection. Data acquired by the Engineer will be made available to Contractor in a timely manner.

G. Contractor may make their own interpretations of monitoring data for their own purposes. Do not publish or disclose data or interpretations shall to other parties without advance written permission of Owner.

H. For data collected from an instrument that has been installed to replace a damaged instrument, use formal initial reading as an initial reading for replacement instrument so that data are continuously plotted, without an offset at time of damage. Note time of damage and replacement on plot.

3.9 INTERPRETATION AND RESPONSE VALUES

A. Make interpretations of data resulting from monitoring programs.

B. Threshold and Limiting Values for Instruments:

	Instrument	Threshold Value	Limiting Value
1.	Seismographs:	1.0 in/sec over 10 Hz	2.0 in/sec over 10 Hz
2.	Surface Monitoring Points:	0.5 inch	1.0 inch
3.	Deformation Monitoring Points:	0.25 inch	0.5 inch
4.	Utility Monitoring Points:	0.25 inch	0.5 inch
5.	Excavation Support:	1.0 inch	2.0 inches
6.	Observation Wells	2 feet	2 feet *

NOTES: * below bottom of excavation.

C. Values are subject to adjustment by the Engineer as indicated by prevailing conditions or project circumstances. Crack Gauge criteria will be established based upon existing conditions identified during preconstruction survey.

D. If a Threshold Value is reached:
   1. Engineer and Contractor will meet to discuss remedial measures.
   2. Increase instrument monitoring frequency as directed by the Engineer.
   3. Install and monitor additional instruments as directed by the Engineer.
   4. Implement remedial measures in event Threshold Value is reached, so Limiting Value is not reached.

E. Take necessary steps so Limiting Value is not exceeded. Engineer may direct Contractor to suspend activities in affected area with exception of those actions necessary to avoid exceeding Limiting Value.

3.10 TOLERANCES

A. Survey Measurements: Initial location of each instrumentation elements consisting of determining elevation and horizontal positions with respect to the Engineer approved benchmarks.

B. Monitoring Points (SMPs, DMPs, UMPs and ESMPs):
   1. Instrumentation Elevations: Determine to accuracy of plus/minus 0.01 foot
   2. Horizontal Position of Surface Monitoring Points: Determine to accuracy of plus/minus 0.1 foot
   3. Horizontal Position of Deformation Monitoring Points and Excavation Support Monitoring Points: Determine to accuracy of plus/minus 0.01 foot

C. If actual field conditions prohibit installation at location and specified elevations, obtain prior acceptance from the Engineer for new instrument location and elevations.

3.11 DISPOSITION OF INSTRUMENTS

A. Monitoring Points: Remove monitoring points during cleanup and restoration work, unless directed otherwise by the Engineer.

B. Observation Wells and Utility Monitoring Points: When required by the Engineer, abandon and remove protective housings and caps in accordance with required permits. Restore surfaces affected by installation of instruments to their original condition prior to completion of work.
   1. Leave in place any casings located within plan limits of new or existing structures or pipelines or within zone below 1H:1V planes extending downward and out from edges of foundation elements, from downward vertical footprint of pipe, or where removal would otherwise result in ground movements causing adverse settlement to adjacent ground surface, utilities or structures.
   2. Where casings are pulled, fill holes with sand. Where left in place, fill casings with non-shrink cement grout and cut off a minimum of 3 feet below finished ground level or 1 foot below foundation level so as not to interfere with finished structures or pipelines.
   3. Following backfilling, remove precast boxes or vaults and reconstruct pavement in paved areas. Restore surface to conditions existing prior to instrument installation.

C. Seismographs: Remove units following completion of installation of excavation support and excavation

END OF SECTION 310900

SECTION 311000 - SITE CLEARING

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. Removing existing vegetation.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Stripping and stockpiling rock.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
7. Obtain all permits required for site clearing work prior to proceeding with the work.

B. Related Requirements:
1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.
2. Section 015639 “Temporary Tree and Plant Protection” for temporary protection of existing vegetation.
3. Section 312316 “Rock Removal” for rock and boulder excavation.
4. Section 312500 “Erosion and Sedimentation Controls” for temporary protection of erosion and sedimentation.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. The Contractor is responsible for confirming that the existing site substantially matches the Drawings and existing conditions during bid prior to beginning Work. Prior to beginning Work under this Section, the Contractor shall meet with the Engineer to identify and discuss those materials to be removed and disposed of by the Contractor.

1.5 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed photographs or video recordings.
   2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 QUALITY ASSURANCE

A. Submit, in accordance with Section 013000, copies of all permits required prior to clearing, grubbing, and stripping work.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed roadways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

C. Utility Locator Service: Notify MISS DIG for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earthwork."
   1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.
   1. Restore damaged improvements to their original condition, as acceptable to Owner.

C. Call Local Utility Line Information service not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer’s written permission.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
   2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
   3. Use only hand methods or air spade for grubbing within protection zones.
   4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
   1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
   1. Limit height of topsoil stockpiles to 72 inches.
   2. Do not stockpile topsoil within protection zones.
   3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.6 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.
   1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
   1. Limit height of rock stockpiles to 36 inches.
   2. Do not stockpile rock within protection zones.
   3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
   1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
   2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other project work.

END OF SECTION 311000

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SECTION 312000 – EARTHWORK

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. General: Earthwork includes clearing and stripping, procurement of on-site and imported fill material, excavating, placing, and compacting fill and backfill, structural excavating and backfilling, transportation and storage of excess earthwork materials; disposal of unsuitable, waste, and surplus materials; restoration of excavation and trench surfaces; and subsidiary work necessary to complete the grading of developed areas to conform with required lines, grades, and slopes.

B. Work includes but is not necessarily limited to; excavation for structures, foundations, manholes, vaults, electrical manholes, conduits, cables, raceways and ducts, pipes, paving; embankments; grading; and related work such as sheeting, bracing and dewatering.

C. Provide services of a licensed Professional Engineer registered in the State which the work is located, to prepare temporary excavation support system, dewatering system designs, and submittals.

D. Provide temporary excavation support systems, including sheeting, shoring, and bracing, to ensure the safety of personnel and protect adjacent structures, piping, and other materials in accordance with Federal, State and local laws, regulations, and requirements. Temporary excavation support systems are specified in Section 315000 “Excavation Support and Protection.”

E. Provide temporary dewatering, surface water control systems, and operate to dewater and maintain excavations in a dry condition. Control drainage into excavations and remove seepage water and rainwater. Dewatering and surface water control are specified in Section 312319 “Dewatering.”

F. Examine site and review available geotechnical report prior to submitting a proposal, taking into consideration project conditions that may affect the work. Owner and Design Engineer do not assume responsibility for variations of subsurface conditions at locations other than places shown and at the time investigations were made.

G. Do not initiate extra work without written notification to Owner and Engineer and receiving Owner’s written approval in response.

H. Protect existing structures and utilities that remain.

I. Related Requirements:

1. Section 013200 "Construction Progress Documentation"
2. Section 013233 "Photographic Documentation" for recording pre-excavation and earthwork progress.
3. Section 310515 “Soils and Aggregates for Earthwork” for fill materials.
4. Section 311000 "Site Clearing" for site preparation work, including stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Section 310900 “Geotechnical Instrumentation and Monitoring” to measure earthwork activities.
6. Section 312333 “Trenching and Backfilling” for stated work.
7. Section 312319 "Dewatering" for controlling surface and groundwater and disposing of water during construction.
8. Section 312500 “Erosion and Sedimentation Controls” for temporary stated work.
9. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
10. Section 321216 “Asphalt Paving” for flexible paving system.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices for earthwork specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

C. Coverage: Pass of compaction equipment over the complete surface area of exposed lift or subgrade to receive compaction.

D. Excavation: Removal and disposal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions to remove unsuitable material as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   2. Unauthorized Additional Excavation: Excavation as directed by Engineer to correct Contractor’s work not in compliance with Contract Documents, which will be performed without additional compensation.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be provided without additional compensation.

E. Finished Grade: Required final grade elevation indicated on Drawings. Spot elevations take precedent over proposed contours.

F. In-the-Dry: An excavation subgrade where groundwater level: has been lowered to at least 2 feet below lowest level of excavation; is stable with no ponded water, mud, or muck; is able to support construction equipment without rutting or disturbance; and is suitable for placement and compaction of fill material, pipe, or concrete foundations.

G. Objectionable Material: Includes topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over 6 inches in maximum dimension.

H. Optimum Moisture Content: Moisture content (percent by dry weight) corresponding to maximum dry density of the same material as determined by ASTM Test Method D1557.

I. Overexcavation: Removal of unsuitable material or objectionable material at or below the normal grade of excavation or subgrade as indicated on Drawings.

J. Percent Compaction: Required in-place dry density of the material, expressed as a percentage of the maximum dry density of the same material, as determined in the laboratory by ASTM Test Method D1557.

K. Structures: Buildings, wet wells, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, manholes and vaults, or other man-made stationary features constructed above or below the ground surface.

L. Subgrade: Required surface of subsoil, borrow fill, or compacted fill that is immediately beneath site improvements, especially dimensioned fill, paving, or other surfacing material.

M. Unsuitable Material: Includes existing fill materials, organic soils, weak native soils, or clays with a plasticity index of greater than 30, and any materials that cannot be properly placed and compacted as specified.

N. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

O. Zone of Influence: A line extending at least 2 feet beyond foundation or pipeline edge, then outward and downward at a slope of 1 horizontal to 1 vertical. Do no excavation below foundation of existing structures or pipeline.

P. Professional Engineer: Registered Professional Engineer meeting project qualifications and who is hired by Contractor.

Q. The Engineer: The Engineer or designated representative hired by Owner.
1. Approval given by the Engineer shall not relieve Contractor of its responsibilities for performing the work in accordance with Contract Document requirements.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct pre-excavation conference at Project site.
1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
a. Personnel and equipment needed to make progress and avoid delays.

b. Coordination of Work with utility locator service.
c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
d. Extent of trenching by hand or with air spade.
e. Field quality control.
f. Contractor Location of Existing Utilities

1.6 ACTION SUBMITTALS

A. Submit in accordance with Section 013300, the proposed methods of dewatering, support of excavation, filling and compaction for the various portions of the work and geotechnical instrumentation submittals specified in other Sections.

B. Site Characterization Data: Submit following information regarding off-site source and material:
1. Site location.
2. Present and past usage of the source site and material.
3. Previously existing reports associated with an assessment of source site relating to presence of oil or other hazardous materials.
4. Location within the site from which the material will be obtained.

C. Samples: Submit a representative sample weighing approximately 50 pounds of each fill material, filter sand, and crushed stone contained in sealed 5 gallon containers, at least 30 calendar days prior to date of anticipated use of each material.

D. Submit laboratory test results for fill materials that include maximum density, gradation, Atterberg limits, sand equivalent, and other applicable criteria, at least 72 hours prior to importing or placing fill.

E. Prepare excavation support system designs by a licensed Professional Engineer, registered in the State of Michigan, and having a minimum of 5 years of professional experience in design and construction of excavation support systems.
1. Submit an original and three copies of licensed Professional Engineer's certification, on PE form specified in Section 013300, stating excavation support systems designs have been prepared by Professional Engineer who is responsible for their execution.

1.7 INFORMATIONAL SUBMITTALS

A. Construction and Operations Plan: Submit proposed methods and sequence of construction, including earthwork operations, excavation limits, slopes, fill material moisture conditioning and handling, compaction equipment, excavation support systems designs, backfilling and filling and compaction, and material sources.
1. Submit excavation support system plan as prepared by registered Professional Engineer complying with requirements stated in previous Article.

B. Submit copies of field daily reports by soil technician at the end of each work day that earthwork and grading operations occur.

C. Upon completion of earthwork and grading operations, submit an as-graded map showing density test numbers and locations, a table of density test results and depths, and a certification of compliance by geotechnical engineer in charge.

D. Qualification Data: For qualified testing agency to conduct geotechnical observation, testing and documentation. include qualifications of firm, resumes of soil technicians assigned to the project, and licensed geotechnical engineer in charge.
   1. Firm Qualifications: Meet ASTM D3740.
   2. Soil Technicians: Have minimum three years demonstrated experience in earthwork and grading operations and satisfy certification requirements of agency having local jurisdiction.
      a. The Engineer reserves right to request substitution of soil technicians assigned to field work. Do not substitute assigned soil technicians without prior approval of the Engineer.

E. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

F. Submit test reports verifying suitability of each footing, slab and foundation subgrade material in accordance with the specified requirements.

1.8 QUALITY ASSURANCE

A. Excavation, trenching, sheeting, bracing, and similar work shall comply with requirements of OSHA excavation safety standards, 29 CFR Part 1926 Subpart P and State and local authorities having jurisdiction. Where conflict between OSHA, State and local regulations exists, apply most stringent requirements.

B. At least three working days prior to starting any excavation, notify the appropriate regional notification center for underground utilities and underground utility owners who are not members of notification center. To obtain area specific information for project site, refer to www.call 811.com.

C. Quality Control Testing for Off-site Borrow Materials:
   1. Chemical testing will not be required where site characterization of off-site borrow sources indicates that soils are acceptable for use. If site characterization data or materials are suspected of being contaminated, perform chemical testing as directed by The Engineer with no additional compensation.
   2. Chemical Test Data: Test each material source requiring testing by a person experienced in sample collection who is a registered Professional Engineer or geologist, or certified groundwater or environmental professional registered in the State of Michigan. Submit samples of each proposed material to a chemical analytical laboratory, certified by the governing agency, for following analyses:
      a. Volatile Organic Compounds: EPA 8240 plus Hazardous Substance List (HSL) Parameters.
      b. Acid and Base Neutral Extractable Organic Compounds: EPA 8270.
      c. Pesticides and PCBs: EPA 8080.
      d. Total Petroleum Hydrocarbons: Infrared Method, EPA 9071/418.1.
      e. Thirteen Priority Pollutant Metals: EPA 7000 Series.

f. Total Cyanide: EPA 9012.

3. Obtain and test off-site borrow samples in accordance with criteria established by the Engineer. Submit results for review and approval prior to use on site.

D. Prior to and during the placement of backfill and fill, coordinate with the soils testing laboratory to perform in-place soil density tests to verify that the backfill/fill material has been compacted in accordance with the compaction requirements specified in Section 312333. The Engineer may designate areas to be tested.

1.9 FIELD CONDITIONS

A. Be responsible for construction layout and reference staking necessary for proper control and satisfactory completion of structures, cutting, filling, grading, drainage, fencing, embankment improvements, curbing, and other appurtenances.

B. Perform construction layout and staking by a Professional Surveyor or Professional Engineer registered in the State of Michigan, experienced and skilled in construction layout and staking requirements.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earthwork operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

D. Utility Locator Service: Notify "Miss DIGG" for area where Project is located before beginning earthwork operations.

E. Do not commence earthwork operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls" andSection 311000 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Fill materials designated for use in this Section are specified in Section 310515 “Soils and Aggregates for Earthwork.”

B. On-Site Fill Material: Earth and rock material obtained at project site during excavation, following clearing and stripping, from which any Unsuitable Soil or Objectionable Material has been removed.

C. General: Provide imported fill materials when sufficient satisfactory soil materials are not available from excavations.

2.2 MATERIALS - NONWOVEN GEOTEXTILES

A. Manufacturers:
1. CSIGeoturf.
2. Tensar International.
3. Substitutions: As specified in Section 016000 “Product Requirements”.
4. Furnish materials according to State of Michigan Department of Transportation standards.

B. Description:
1. Non-biodegradable, non-reactive (for pH of three to eleven), UV-resistant, insect/rodent-resistant woven material consisting of filaments formed into a stable network.
2. Edges: finished to prevent separation of outer material.

C. Performance and Design Criteria:
1. When tested in accordance with ASTM D 4759, test results from any sampled roll in the lot shall meet or exceed the values listed in Table 1. Strength values are in the weaker principal direction.

TABLE 1: WOVEN GEOTEXTILE MINIMUM AVERAGE ROLL VALUES

PROPERTIES	TEST METHOD	UNIT	Geoturf WS200
Grab Strength	ASTM D 4632	lbs	200
Grab Elongation	ASTM D 4632	percent	15%
Trapezoid Tear Strength	ASTM D 4533	lbs	75
Puncture Strength (CBR)	ASTM D 4833/ D 6241	lbs	700
Water Flow Rate	ASTM D 4491	gpm/ft2	4
Permittivity	ASTM D 4491	sec-1	0.05
Apparent Opening Size (Max)	ASTM D 4751	US Std. Sieve	40
UV Resistance	ASTM D 4355	percent strength retained	80%

TABLE 2: GEOGRID MINIMUM AVERAGE ROLL VALUES

PROPERTIES	TEST METHOD	UNIT	Tensar TX-7	Tensar TX-160	Tensar 190L
Junction Efficiency	ASTM D6637-10/ ASTM D7737	percent		93%	93%
Isotropic Stiffness Ratio		ratio		3.6	.6
Radial Stiffness at Low Strain	ASTM D 6637-10	Lbs/ft		20,580	23,989
Chemical Resistance	EPA 9090	percentage		100%	100%
UV Resistance	ASTM D 4355-05	percent strength re-tained		100%	70%

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, tanks utilities, sidewalks, pavements, fencing, landscaping, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
   1. If necessary, remove and restore or replace curbing, driveway aprons, and fencing after performing backfilling work.
   2. Replace existing facilities damaged by construction with new material fully equal to existing without additional compensation.

B. Prior to and During Earthwork Operations:
   1. Provide, monitor, and maintain geotechnical instrumentation regarding settlement; coordinate with Section 310900 “Geotechnical Instrumentation and Monitoring.”
   2. Protect and maintain erosion and sedimentation controls; coordinate with Section 312500 “Erosion and Sedimentation Controls.”
   3. Provide, monitor, and maintain excavation support; coordinate with Section 315000 “Excavation Support and Protection.”
      a. Use excavation support system for excavations within the zone of influence for existing structures or utilities.
      b. Do not permit excavations below base level of adjacent foundations or retaining walls, unless excavation design and bracing includes an analysis of structure’s stability supported by the foundation. When necessary due to project conditions, incorporate required bracing and foundation underpinning.
   4. Provide, monitor, and maintain dewatering and drainage systems; coordinate with Section 312319 “Dewatering.”

C. Test Pits:
   1. Perform exploratory excavation work, using vacuum excavating techniques, for purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work.
   2. Backfill and compact test pits as soon as desired information has been obtained. Stabilize backfilled surfaces in accordance with approved erosion and sedimentation control plans.

D. Clearing and Stripping. Initially clear and strip ground surfaces beneath planned structures and in areas requiring excavation or filling of organic material and debris. Do not use those materials as On-Site Fill Material; remove from the site and properly dispose of excavated material.
   1. Stripping Depth Variance: From about 24 inches to 60 inches.

E. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

F. Saw cut existing pavement with a saw, wheel, or pneumatic chisel along straight lines before excavating.

3.2 DEWATERING AND DRAINAGE

A. Provide dewatering and drainage in accordance with Section 312319 “Dewatering”. This Article supplements those requirements.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff and groundwater seepage away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Prior to excavation, verify groundwater will be at required level indicated on approved dewatering and drainage submittal.

E. Accomplish dewatering by methods that preserve undisturbed state of subgrade soils. Dewater in a manner to prevent boiling, detrimental under-seepage, or disturbance at excavation base.

3.3 SUPPORT OF EXCAVATION

A. Provide excavation support in accordance with Section 315000 “Excavation Support and Protection.” This Article supplements those requirements.

B. Install excavation support in accordance with reviewed Shop Drawings prior to beginning excavation work. Maintain excavation supports that are required to remain in place, if applicable, as indicated on Drawings or as required by approved Shop Drawings.

C. Construct temporary excavation slopes in accordance with the requirements of OSHA excavation safety standards and approved Shop Drawings.

D. Where allowed, carefully remove excavation supports in a manner without endangering the Work or other adjacent structures, utilities, or property. Immediately fill voids left or caused by withdrawal of supports with sand and compact.

3.4 EXCAVATION

A. Include material of every description and of whatever substance encountered as an unclassified excavation.

B. General: Excavate on-site soils using standard earthmoving equipment. Excavation in dense soil or rock may require special equipment. Do not plough, scrape, or dig earth with machinery so near to finished subgrade to result in excavation of or disturbance of below grade material.

C. Make excavations to grades indicated on Drawings and in widths sufficient for laying of pipe, construction of the structure, installing bracing, excavation supports, dewatering and drainage facilities, and working clearances.

D. Perform excavation in-the-dry and accomplished by methods which preserve the natural undisturbed condition of subgrade soils.

E. Moisture Sensitive Soils: Use a smooth-edge bucket to excavate last one foot of depth when excavation is to end in such soils.

F. If excavation bottom is removed below the limits shown on Drawings, without direction by the Engineer, refill with structural fill satisfactory to the Engineer without additional compensation.

G. When excavation has reached prescribed depths, notify the Engineer who will observe the conditions. If materials and conditions are not satisfactory, the Engineer will issue instructions for corrective procedures. The Engineer will be the sole judge as to whether the work has been accomplished satisfactorily.

H. Subgrade soils that have become soft, loose, quick, or otherwise unsatisfactory due to inadequate excavation, dewatering, or other construction methods in the opinion of the Engineer, shall be removed and replaced with structural fill as acceptable to the Engineer at Contractor's expense.

I. Exposed subgrades in large open areas or for foundations shall be proof rolled with at least two overlapping coverages of a vibratory drum roller with a minimum static drum weight of 10 ton. Conduct proof-rolling in presence of the Engineer. The Engineer will waive this requirement, if in its opinion the subgrade will be rendered unsuitable by such proof-rolling.
   1. Confined Areas: Proof-roll with hand operated vibratory equipment that is approved by the Engineer.

J. Perform over excavation at the Engineer’s request to remove unsuitable soil, objectionable material, or other materials as determined by the Engineer and to such depth and width as directed. Replace with suitable material as directed by the Engineer.
   1. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

K. Perform excavation for pipe lines beneath structures and excavation for footings with excavating equipment operating from the subgrade for the structure, while in-the-dry and in a manner preserving the undisturbed state of subgrade soils.

L. When excavations have reached the required subgrade, including any allowances for working mats or base materials and prior to their placement, notify soils testing laboratory to verify suitability of existing subgrade soils for anticipated foundation and structural loadings.
   1. If existing subgrade soils are determined to be unsuitable, follow direction provided by the Engineer regarding removal and replacement with suitable materials.
   2. Notify the Engineer if the revised work scope would modify Contractor's cost and thereby entitle a change to the Contract Sum. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

M. Replace over excavation beyond the limits and depths required by Contract Documents using structural fill satisfactory to the Engineer without additional compensation.

3.5 SUBGRADE PREPARATION

A. Notify Engineer when excavations have reached required subgrade.

B. Maintain excavated subgrade in-the-dry condition.

C. Prior to fill placement, remove objectionable material which includes, but not be limited to, pavement, topsoil, organic matter, contaminated soil, construction debris, perishable materials, snow, ice, frozen earth, and rocks or lumps of cemented soils over 6 inches in maximum dimension.

D. For subgrades consisting of granular soils, proof roll the final subgrade using at least four coverages of a vibrator plate compactor.

E. Where existing subgrade contains a significant amount of clay or cohesive soils, over-excavate sufficiently below the bottom of structure for placement of a lean concrete working mat. Remove loose or soft material from the subgrade immediately prior to placing lean concrete working mat.

F. Remove and replace soft subgrades or unusable material with structural fill or common fill subject to the prior approval of the Engineer.

G. During wet or freezing weather, or in areas where exposed subgrade consists of moisture-sensitive soils, take measures to protect foundation excavations once they have been approved by the Engineer. Protective measures include, but are not limited to, placing insulation blankets, placing a layer of fill, pea gravel, crushed rock, or lean concrete on the exposed subgrade, or covering the exposed subgrade with a plastic tent.
   1. If additional over excavation is required due to the subgrade not being protected against wet or freezing weather, perform additional work without additional compensation.

H. Notify the Engineer to observe conditions following subgrade preparation and prior to fill placement. If existing subgrade soils are determined to be unsuitable, follow direction provided by the Engineer regarding removal and replacement with suitable materials.
   1. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

3.6 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust. Protect from precipitation.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.7 FILL PLACEMENT AND COMPACTION PROCEDURES

A. Fill and Backfill: Place materials in lifts to suit specified compaction requirements to required lines and grades, making allowances for settlement and placement of cover materials, such as topsoil or sod. Correct soft spots or uncompacted areas.

B. Do not place or compact fill and backfill when materials are too wet to properly compact.
   1. In-place Soil Moisture Content: Maximum of three percentage points above optimum moisture content of soil, as determined by laboratory test of moisture-density relation appropriate to specified level of compaction.

C. Structural Fill and Embankment Fill: Construct to required lines and grades, making allowances for settlement and placement of cover materials, such as topsoil and sod. Correct soft spots or uncompacted areas.

D. Fill material shall be free of snow, ice, frost, and frozen earth. Do not place fill materials on frozen surfaces or surfaces covered by snow, ice, or frost.

E. Complete structure water-tightness tests and installation of dampproofing or waterproofing systems prior to placing various types of fill or backfill around structures.

F. If subgrade slopes more than 10 percent, step subgrade to produce a stable, horizontal surface for placement of fill materials. Scarify existing subgrade slope to a depth of at least 6 inches.

G. Compact filled slopes by slope rolling and trimming or overfill and trim back to plan grade to expose a firm, smooth surface free of loose material.

H. Do not allow fill lifts to contain stones with a dimension larger than 2/3 the specified loose measure lift thickness.

I. Perform compaction in open areas using compaction equipment by any of the following methods:
   1. Fully loaded ten-wheel trucks or front-end loaders.
   2. Tractor dozers weighing minimum of 30,000 pounds.
   3. Heavy vibratory rollers.

J. Confined Compaction: Perform compaction in confined areas, including areas within a 45-degree angle extending upward and outward from the base of a wall, and in areas where the use of large equipment is impractical, using hand-operated vibratory equipment or mechanical tampers.
   1. Do not exceed lift thickness of 6 inches, measured before compaction, when using hand operated equipment.

K. Moisture condition on-site fill material prior to placement, unless Contractor demonstrates to the Engineer in-place moisture conditioning methods can achieve the required moisture content.

L. Conduct compaction of each specified lift of fill materials by a minimum of four complete coverages with acceptable compaction equipment to a specified density as a percentage of maximum dry density as determined by ASTM D1557, unless otherwise specified.

M. Use structural fill required beneath foundations or slabs on grade, except sidewalks. Place and compact structural fill in even lifts having a maximum thickness of 8 inches, measured before compaction.

N. Use select fill and backfill material placed within 10 feet of all structures. Uniformly place and compact select fill around the structure in even lifts having a maximum thickness of 8 inches, measured before compaction.

O. Use common fill in areas beyond those designated for structural fill or select fill, unless shown or otherwise specified. Place in even lifts having a maximum thickness of 12 inches, measured before compaction.

P. Place impervious fill in controlled, even lifts having a maximum thickness (measured before compaction) of 6 inches.
   1. Permeability: Compact to attain a reading of less than 1 x 10^{-7} cm/sec.
   2. Moisture Content: Compact to optimum moisture content of minus 2 percent to plus 3 percent.

3.8 COMPACTION REQUIREMENTS

A. Perform in-place testing of compacted fill lifts to measure in-place density and water content according to ASTM D1557.

B. Beneath Foundations and Slabs-on-Grade, except sidewalks: Compact top 12 inches of existing subgrade and each layer of fill, if applicable to:
   1. Maximum Dry Density: Minimum of 95 percent for ASTM D1557.
   2. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 3 percent.

C. Area Around Structures: Within 10 feetcompact each fill or backfill layer to:
   1. Maximum Dry Density: Minimum of 95 percent for ASTM D1557.
   2. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 3 percent.

D. Embankments, Lawn, or Unimproved Areas: Does not include embankments under roadways and earth dam structures. Compact each fill or backfill layer to:
   1. Maximum Dry Density: Minimum of 90 percent for ASTM D1557.
   2. Moisture Content: At or near its optimum moisture content of minus 1 percent to plus 4 percent.

E. Sidewalks: Compact each fill layer to:
   1. Maximum Dry Density: Minimum of 95 percent for ASTM D1557.
   2. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 3 percent.

F. Roads, Paved Areas, and Roadway Embankments: Compact each layer of fill or backfill to:
   1. Maximum Dry Density: Minimum of 95 percent for ASTM D1557.
   2. Moisture Content: At or near its optimum moisture content of minus 2 percent to plus 3 percent.

3.9 DISPOSAL OF UNSUITABLE, WASTE, AND SURPLUS EXCAVATED MATERIALS

A. Unsuitable soil, objectionable material, waste, and surplus excavated material shall be removed and disposed of off-site. Materials may be temporarily stockpiled in an area within the limits of construction that does not disrupt construction activities, create any nuisances or safety hazards, or otherwise restricts access to work site.

B. Topsoil or loam excavated under this Section may be salvaged for use as specified under Section 329200 “Turf and Grasses”, as approved by the Engineer.

3.10 GRADING

A. Perform grading to lines and grades shown on Drawings. Remove objectionable materials encountered within the limits indicated and disposed of off-site. Completely and continuously drained and dewatered subgrades throughout the grading process. Install temporary drains and drainage ditches to intercept or divert surface water that may affect the execution or condition of grading work.

B. If it is not possible at the time of grading to place material in its proper section of the Work, stockpile it in approved areas for later use. No additional compensation will be made for stockpiling or double handling of excavated materials.

C. In cut areas, remove loose or protruding rocks in slopes to line or finished grade of the slope. Uniformly dress, cut, and fill slopes to slope cross-section and alignment shown on Drawings, unless otherwise directed by the Engineer.

3.11 FIELD QUALITY CONTROL

A. Test and observe materials as described in this Article. Cooperate by allowing free access to work for selection of test materials and observations.

B. General Testing Requirements:
   1. At Structures: Prior to placement of bedding material, concrete work mats, structural fill or structural concrete, coordinate with Project Geotechnical Engineer or Soils Testing Laboratory to verify suitability of existing subgrade soil.
   2. Backfill and Fill: Prior to and during the placement of backfill and fill coordinate with Project Geotechnical Engineer or Soils Testing Laboratory to perform in-place soil density tests to verify that backfill and fill material has been placed and compacted in accordance with specified compaction requirements.
      a. Provide minimum 48 hours’ notice prior to placement of backfill and fill.
   3. Subgrade: Do not cover with fill without observation, testing, and approval by Project Geotechnical Engineer or Soils Testing Laboratory.
      a. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer without additional compensation.

C. Test materials by a certified independent laboratory, engaged by Contractor and acceptable to the Engineer, demonstrating conformance with project requirements. Deliver test reports and material certifications to the Engineer before using any material in the work.

D. If field test results are not in conformance with project requirements, costs involved in correcting deficiencies in compacted materials to satisfaction of the Engineer without additional compensation.

E. Earthwork activities performed without properly scheduled inspection are subject to removal and replacement or additional testing as directed by the Engineer without additional compensation.

F. Testing methods shall comply with latest ASTM or equivalent AASHTO Standards applicable during bidding.

G. During placement of bedding, backfill, and fill, perform in-place soil density testing to confirm that fill material has been compacted in accordance with project requirements. The Engineer may designate areas to be tested. Notify the Engineer at least 72 hours in advance of scheduled compaction testing. In place soil density tests on backfill and fill material shall be as required by authorities having jurisdiction, project geotechnical report, but in no instance, shall less than those listed:
   1. Structures and Embankments: At least one density and moisture content test for each 2,500 square feet of surface area for each lift of fill at embankment, structure, and manhole locations.
   2. Trench Excavations: At least one nuclear density and one moisture content test at a maximum of 50 feet intervals for each lift of fill placed or as directed by the Engineer.
   3. The Engineer may designate supplemental areas to be tested at additional compensation.

H. Materials which have been previously tested may be subjected to further testing from time to time and may be rejected, if it is determined that results do not conform to project requirements. Immediately remove rejected materials when directed by the Engineer, notwithstanding results of previous testing.

I. The Engineer or Owner may conduct additional soil testing. Cooperate fully in allowing additional test to be made, including free access to the work.

J. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

3.12 PROTECTION

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

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by the Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION 312000

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SECTION 312319 - DEWATERING

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 temporary construction dewatering and surface water control and incorporates the design, equipment, materials, installation, operation, protection, monitoring and removal of dewatering and drainage system. Provide dewatering system sufficient to lower groundwater and collect surface water, regardless of groundwater level or rainfall at any time during the work.

B. Obtain and pay for permits required for dewatering and drainage systems. Implement measurements to comply with dewatering and discharge permits requirements.

C. Related Requirements:
1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
2. Section 310515 “Soils and Aggregates for Earthwork” for filter sand.
3. Section 310519 “Geotextiles for Earthwork” for filter fabric materials.
4. Section 310900 “Geotechnical Instrumentation and Monitoring” for monitoring.
5. Section 312000 "Earthwork" for excavating, backfilling.
6. Section 312316 “Rock Removal” for removal of rock and boulders.
7. Section 312333 “Trenching and Backfilling” for trenching, backfilling, and compaction.
8. Section 312500 “Erosion and Sedimentation Controls” for controlling surface-water runoff and ponding.
9. Section 315000 “Excavation Support and Protection” for support of excavations.
10. Division 32 “Site Improvements” for various Sections relating to civil and landscape related work.

1.3 DEFINITIONS

A. In-the-Dry: An excavation subgrade where all of the following are met:
1. Groundwater level has been lowered to at least 2 feet below lowest excavation level.
2. Subgrade is stable with no ponded water, mud, or muck.
3. Subgrade is able to support construction equipment without rutting or disturbance.
4. Subgrade is suitable for placement and compaction of fill material, pipe, or concrete foundations.

B. Contractor’s Engineered Design: Design prepared on behalf of Contractor by a registered Professional Engineer.

C. Professional Engineer: Registered Professional Engineer meeting project qualifications and who is hired by Contractor.

D. The Engineer: Engineer hired by Owner.
   1. Approvals given by The Engineer shall not relieve Contractor of its responsibilities for performing the work in accordance with Contract Document requirements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.
   1. Verify availability of Installer's personnel, equipment, and facilities needed to perform the work, make progress and avoid delays.
   2. Review condition of site to be dewatered including coordination with temporary erosion-control measures, excavation support systems, and temporary controls and protections.
   3. Review geotechnical report.
   4. Review proposed site clearing and excavations.
   5. Review existing utilities and subsurface conditions.
   6. Review observation and monitoring of dewatering system.
   7. Review sampling and testing requirements for discharge.
   8. Review pretreatment requirements prior to discharge, discharge location(s), and flow rate requirements.

1.5 ACTION SUBMITTALS

A. Design Plan: Submit written dewatering and drainage system design plan, prepared by a qualified Professional Engineer, that includes:
   1. Description of proposed dewatering system and installation methods to be used for system elements and observation wells.
   2. Description of equipment, drilling methods, holes sizes, filter sand placement techniques, sealing materials, development techniques, number and location of dewatering points and observations wells.
   3. Dewatering system design calculations demonstrating that the proposed system meets all requirements herein and elsewhere.
   4. Sequence of well and well-point placement coordinated with support of excavation system installation and control procedures to be adopted, if dewatering problems arise.
   5. Identification of anticipated area influenced by dewatering system and address impacts to adjacent existing and proposed structures.
      a. Include detailed plans for pre-construction surveys of existing structures in vicinity of dewatering system, settlement monitoring of existing structures during construction, and provisions to address settlement of existing structures resulting from dewatering activities.
   6. Coordinate dewatering and drainage submittals with excavation and support of excavation submittals.

B. Shop Drawings: For dewatering system, prepared by a qualified Professional Engineer.
   1. Include plans, elevations, sections, and details.
   2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.

3. Include pump capacity and anticipated discharge rate.
4. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
5. Show areas and depths of excavation to be dewatered and adjacent structures or facilities within the anticipated area influence.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer land surveyor and Professional Engineer.

B. Field quality-control reports.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

E. Discharge sampling log, testing results of effluent samples and flow rate record.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in installation of dewatering systems and dewatering work and having a minimum of 5 years' experience.

B. Professional Engineer Qualifications: Licensed Professional Engineer registered in the State of Michigan; having a minimum of 5 years' experience in design and construction of dewatering and drainage systems; and having completed not less than 5 successful dewatering and drainage projects of equal type, size, and complexity to that required for the work.

C. Comply with authorities having jurisdiction for the following:
1. Drilling and abandoning of wells used for dewatering systems.
2. Water discharge and disposal from dewatering operations.

D. Obtain permit from EPA under National Pollutant Discharge Elimination System (NPDES), for storm water discharge from construction sites.

1.8 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. Owner is not responsible for interpretations or conclusions drawn from this report.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
2. Groundwater levels may vary during the work and should not be assumed to be accurately represented by groundwater level readings reported in the geotechnical report.
3. The geotechnical report is included elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or Professional Engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of surface and ground water and permit excavation and construction to proceed in-the-dry in accordance with the requirements herein and elsewhere.
   1. Design dewatering system, including comprehensive engineering analysis by a Contractor's Design Engineer.
   2. Continuously monitor and maintain dewatering operations to ensure required groundwater lowering, erosion control, stability of excavations, excavation support, and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
   3. Prevent surface water from entering excavations by grading, dikes, or other means.
   4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
   5. Remove dewatering system when no longer required for construction.

B. Primary Purpose of Work: Preserve natural undisturbed condition of subgrade soils in areas of proposed excavations.
   1. Prior to excavation, lower groundwater to at least 2 feet below lowest excavation subgrade elevation.
   2. Additional groundwater lowering may be necessary beyond 2 feet requirement, depending on construction methods, equipment used, and prevailing groundwater and soil conditions. Lower groundwater as necessary to complete construction in accordance with Contract Documents without additional compensation

C. Design deep wells, well points and sumps, and other groundwater control system components to prevent loss of fines from surrounding soils. Use sand filters with dewatering installations, unless screens are properly sized by Contractor's design engineer to prevent passage of fines from surrounding soils.

D. Maintain standby pumping systems and sources of standby power at various sites.

E. Design dewatering system to prevent damage to adjacent properties, buildings, structures, utilities, and facilities from dewatering operations. Be responsible for damage to properties, buildings or structures, sewers and other utility installations, pavements, and work that may result from dewatering or surface water control operations.

F. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

2.2 MATERIALS

A. Pipe for Observation Wells: ASTM D 1785, PVC Schedule 80 in minimum interior diameter of 2 inches and machine slotted having a maximum slot size of 0.020 inch. Coordinate with Section 310900 “Geotechnical Instrumentation and Monitoring.”

B. Equipment: Piping, pumping, and other equipment and materials to provide control of surface water and groundwater in excavations.

C. Grout: Mixture of portland cement and bentonite clay or sand suitable for sealing abandoned wells and piping.

PART 3 - EXECUTION

3.1 GENERAL

A. Control surface water and groundwater such that:
   1. Excavation to final grade is made in-the-dry.
   2. Natural undisturbed conditions of subgrade soils are maintained.
   3. Softening, instability, or disturbance due to presence or seepage of water does not occur.
   4. Construction and backfilling proceeds in-the-dry.
   5. Floatation of completed portions of work shall be prohibited.

B. Methods of groundwater control may include but are not limited to perimeter trenches and sump pumping, perimeter groundwater cutoff, well points, ejectors, deep wells, or any combination.

C. Where groundwater levels are above proposed bottom of excavation level, provide a pumped dewatering system for pre-drainage of soils prior to excavation and for maintaining lowered groundwater level until construction has been completed such that structure, pipeline, or fill will not be floated or otherwise damaged.

D. Vary type of system, spacing of dewatering units, and other details of the work depending on soil and water conditions at each location.

E. Do work in a manner to protect adjacent structures and utilities without causing loss of ground or disturbance to pipe bearing soils or soils supporting overlying or adjacent structures.

F. Install, monitor, and report data from observation wells. Evaluate collected data relative to groundwater control system performance and modify systems necessary to dewater site.

G. Locate groundwater control system components where they will not interfere with construction activities adjacent to the work area or interfere with installation and monitoring of geotechnical instrumentation including observation wells. Do not make excavations for sumps or drainage ditches within or below 1H:1V slopes extending downward and out from edges of existing or proposed foundation elements or from downward vertical footprint of pipe without approval by the Engineer.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
   1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
   2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways, if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 015000 "Temporary Facilities and Controls," during dewatering operations.

3.3 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
   1. Space well points or wells at intervals required to provide sufficient dewatering.
   2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.4 SURFACE WATER CONTROL

A. Construct surface water control measures, including dikes, ditches, sumps and other methods to prevent flow of surface water into excavations and to allow construction to proceed without delay.

B. Grade excavation to divert surface water and seepage water within excavation areas into sumps and dewatering wells.

3.5 EXCAVATION DEWATERING

A. Provide and maintain equipment and facilities to promptly remove and properly dispose of water entering excavations. Maintain excavations in-the-dry.

B. Excavation dewatering shall maintain the subgrade in a natural undisturbed condition and be in operation until the fill, structure or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural elevations.

C. Do not place pipe, masonry, and concrete in water or submerge within 24 hours after being installed. Prevent water from flow over new masonry or concrete within four days after placement.

D. Prevent water from rising to cause unbalanced pressure on structures until concrete or mortar has set at least 24 hours. Prevent pipe flotation by promptly placing backfill.

E. Conduct dewatering to preserve natural undisturbed condition of subgrade soils at bottom of excavation.

F. If trench subgrade or excavation bottom becomes disturbed due to inadequate dewatering or drainage, excavate below normal grade as directed by the Engineer and refill with structural fill, screened gravel, or other material as approved by the Engineer without additional compensation.

G. It is expected that initial dewatering plan may be modified to suit variable soil and water conditions encountered. Dewater and excavate in a manner without causing loss of ground or disturbance to pipe bearing soil or soil that supports overlying or adjacent structures.

H. If methods do not properly dewater excavation, install additional groundwater observation wells as directed by the Engineer. Do not place pipe or structure until readings obtained from observation wells indicate that groundwater has been lowered to specified minimum of below bottom of final excavation.

I. Surround dewatering units with suitable filter sand with no fines being removed by pumping. Pump continuously from dewatering system until pipe or structure is adequately backfilled. Provide stand-by pumps.

J. Collect water entering excavations from precipitation or surface runoff in shallow ditches around excavation perimeter, drained to a sump, and pump from excavation to maintain a bottom free from standing water.

K. Dispose of drainage to an approved area as specified in Section 013543 “Environmental Protection Procedures.” Do not use existing or new sanitary sewers to dispose of drainage.

3.6 WELL-POINT SYSTEMS

A. Where necessary, install a vacuum well-point system around excavation for dewatering purposes. Surround each well-point and riser pipe by a sand or gravel filter. Use sand of gradation that after initial development of well-points, quantity and size of soil particles

discharged shall be negligible. Provide well-point systems capable of operating continuously under highest possible vacuum. Include sufficient valves and gauges to accurately monitor and control the system. Develop and redevelop well-points to provide reliable performance throughout the duration of the work.

B. Install well point systems in the Engineer's presence according with approved submittal.

3.7 DEEP WELLS

A. Where necessary, install a deep well system around an excavation to dewater it. Surround each well with a sand or gravel filter having adequate gradation so quantity and size of soil particles discharged are negligible. Install sufficient number of wells to lower groundwater level allowing excavation to proceed in-the-dry. Develop and redevelop wells as necessary to provide reliable performance throughout the duration of the work.

B. Install deep wells in the Engineer's presence according with approved submittal.

3.8 OBSERVATION WELLS

A. Install observation wells as required under this Section and in accordance with the approved submittal to monitor groundwater levels beneath and around excavated areas until adjacent structures and pipelines are completed and backfilled.

B. Observation Well Locations and Depths:
   1. Install a minimum of 2wells. Locate in critical areas with respect to groundwater control to monitor performance of dewatering systems as determined by Delegated Design.
   2. Install observation wells to:
      a. Minimum depth of 10 feet below deepest level of excavation, unless otherwise approved by the Engineer.
      b. Depth necessary to indicate that groundwater control system designed under Delegated Design is performing as intended.
   3. Provide additional observation wells required by the Engineer if deemed necessary to monitor performance of groundwater control system without additional compensation.
   4. Locations and depths are subject to approval by the Engineer.

C. Protect observation wells at ground surface by providing a lockable box or outer protective casing with lockable top and padlock. Design surface protection to prevent damage by vandalism, construction operations, and surface water infiltration.
   1. Provide two copies of padlock keys at each well for the Engineer's access.
   2. Develop observation wells to provide a reliable indication of groundwater levels. Re-developed wells: if well clogging is observed; in event of apparent erroneous readings; or as directed by the Engineer.
   3. Submittal observation well installation logs, top of casing elevation, and well locations to the Engineer within 24 hours of completing well installation.

D. Observation Well Maintenance:
   1. Maintain each observation well until adjacent structures and pipelines are completed and backfilled. Clean out or replace any observation well which ceases to be operable before adjacent work is completed.

2. Repair or replace wells without additional compensation, whether damage is caused by Contractor's operations or third parties.

E. Monitoring and Reporting of Observation Well Data:
1. Begin daily monitoring of groundwater levels in work areas prior to initial operation of drainage and dewatering system. Continue daily monitoring in areas where groundwater control is in operation until time that adjacent structures and pipelines are completed and backfilled or until time that groundwater control systems are turned off.
2. Be responsible for processing and reporting observation well data to the Engineer on a daily basis. Provide data to the Engineer on a form that includes following information: observation well number, depth to groundwater, total depth of well, top of casing elevation, groundwater level elevation, and date and time of reading.

F. Keep groundwater level at a minimum of 2 feet below lowest subgrade level for a given excavation.

3.9 REMOVAL OF SYSTEMS

A. At completion of excavation and backfilling work and when approved by the Engineer, remove from site various pipe, deep wells, well-points, pumps, generators, observation wells, other equipment, and accessories used for groundwater and surface water control systems.
1. Removed materials and equipment become property of Contractor.

B. Restore areas disturbed by installation and removal of groundwater control systems and observation wells to their original condition.

C. Leave in place deep wells casings, well-points, and observation wells located:
1. Within plan limits of structures or pipelines.
2. Within zone below 1H:1V planes extending downward and out from edges of foundation elements or from downward vertical footprint of pipe.
3. Where removal would result in ground movements causing adverse settlement to adjacent ground surface, utilities, or existing structures.

D. Fill pulled casings holes with sand. Where left in place, fill casings with cement grout and cut off a minimum of 3 feet below finished ground level or 1 foot below foundation level to prevent interference with finished structures or pipelines.

E. When directed by the Engineer, leave observation wells in place for continued monitoring. Cut casings flush with final ground level when directed and provide protective lockable boxes with locking devices. Provide protective boxes suitable for traffic and other conditions to which observation wells will be exposed.

END OF SECTION 312319

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SECTION 312333 - TRENCHING AND BACKFILLING

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 trench excavation, backfilling, and compaction.

B. Related Requirements:
1. Section 310515 “Soils and Aggregates for Earthwork” for materials used as backfill and for sheeting and bracing.
2. Section 312000 “Earthwork” for related earthwork activities.
3. Section 312319 "Dewatering" for dewatering and drainage.
4. Section 312500 “Erosion and Sedimentation Controls” to prevent erosion, sedimentation, and contamination of adjacent properties.
5. Section 329219 “Seeding.”
6. Section 331116 “Site Water Sampling Line”: Water piping and bedding from building to utility service.
7. Section 333100 “Sanitary Sewerage Piping”: Sanitary sewer piping and bedding from building to utility service.

1.3 DEFINITIONS

A. Percent Compaction: Means at least the stated percentage of maximum density as determined by ASTM D 1557, Method D

1.4 ACTION SUBMITTALS

A. Submit proposed method of backfilling and compaction prior to start of Work.

B. Submit method of excavation and trench support, where necessary, including design of sheeting and bracing with calculations signed and sealed by qualified professional engineer in the State of Michigan responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For material excavated from trench for re-use as backfill, by a qualified testing agency.

1.6 QUALITY ASSURANCE

A. Comply with following regulations:
   1. Occupational Safety and Health Administration (OSHA): 29 CFR Part 1926 Subpart P.

B. Provide excavation, trenching, related sheeting, bracing, and related materials to comply with requirements of OSHA excavation safety standards (29 CFR Part 1926 Subpart P) and State of Michigan requirements. Where conflict exists between OSHA and State regulations, more stringent requirements apply.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine that erosion and sedimentation controls are in place and comply with project requirements and authorities having jurisdiction.

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

3.2 PREPARATION

A. Where excavation activities occur across active vehicular or pedestrian circulation paths, use temporary controls specified in Division 01 to maintain circulation during operations required by this Section. Maintain temporary controls for each day circulation paths are restricted.

B. Coordinate work of this Section with materials specified in other Sections of Division 31.

C. Identify required lines, levels, contours, and datum locations.

D. Protect features to remain-in-place including bench marks, existing structures, fences, sidewalks, paving, curbs, etc. from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

3.3 TRENCH EXCAVATION

A. Trench excavation includes material of every description and substance encountered, except rock and boulders.

B. Cut rigid and flexible pavement with a saw, wheel, or pneumatic chisel along straight lines before excavating.

C. Strip and stockpile topsoil from grassed areas crossed by trenches.
   1. At Contractor's option when required, topsoil may be disposed of and replaced with approved topsoil of equal quality.

D. While excavating and backfilling is in progress, maintain traffic and protect utilities and other property.

E. Excavate trenches to indicated depths and in widths sufficient and of practical minimum for pipe laying, bracing, and pumping and drainage facilities.

F. Accomplish excavation and dewatering by methods preserving undisturbed state of subgrade soils. Excavate trench by machinery to or just below designated subgrade, if material remaining in trench bottom is no more than slightly disturbed.
   1. Remove subgrade soils that become soft, loose, quick, or otherwise unsatisfactory due to inadequate excavation, dewatering, or other construction methods and replace with screened gravel fill acceptable to the Engineer at Contractor's expense.

G. Use care when working in clay and organic silt soils, which are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth-edge bucket to excavate the last 12 inches of depth.

H. Where pipe is to be laid in screened gravel bedding, excavate trench by machinery to normal depth of pipe, provided material remaining in trench bottom is no more than slightly disturbed.

I. Where pipe is to be laid directly on trench bottom, manually perform final excavation, providing a flat-bottom, true to grade upon undisturbed material. Make bell holes required by project conditions.

3.4 SHEETING AND BRACING

A. Provide and maintain sheeting and bracing required by Federal, State, or local safety requirements to support sides of excavation and prevent loss of ground which could endanger personnel, damage, adjacent structures, or delay the work.
   1. Engineer may order additional supports placed at Contractor’s expense if it is determined that at any point sufficient or proper supports have not been provided. Compliance with such order shall not relieve Contractor from their responsibility for sufficiency of such supports. Take care to prevent voids outside of sheeting; if voids are formed, immediately fill and ram them.

B. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support trench sides, take care in placing and moving the boxes or supporting bracing to prevent pipe movement, disturbance of pipe bedding, or screened gravel backfill.
   1. Rigid Pipe Installation (such as R.C., V.C., A.C.): Raise that portion of box extending below mid-diameter above this point prior to moving box ahead to install next pipe. Perform to prevent separation of installed pipe joints due to box movement.
   2. Flexible Pipe Installation (such as PVC): Do not allow trench boxes, moveable sheeting, shoring, or plates to extend below mid-diameter of pipe. As trench boxes, moveable sheeting, shoring, or plates are moved, place screened gravel to fill voids created. Re-compact screened gravel and backfill to provide uniform side support for pipe.

C. Engineer may give permission to use steel sheeting in lieu of wood sheeting for entire job wherever sheeting use is necessary. Include cost for use of sheeting in bid items for pipe, including full compensation for driving, bracing, and later removal of sheeting.

D. Carefully remove sheeting and bracing in manner to not endanger construction of other structures, utilities, or property, whether public or private. Immediately refill voids left after withdrawal of sheeting using sand by ramming with tools especially adapted to that purpose and watering or otherwise directed by the Engineer.

E. No payment will be given for sheeting, bracing, or other support during progress of the work. No payment will be given for sheeting left in trench for Contractor's convenience.

F. Leave sheeting driven below mid-diameter of pipe in place from driven elevation to at least 12 inches above top of pipe.

3.5 TEST PITS

A. Excavation of test pits may be required for purpose of locating underground utilities or structures as an aid in establishing the precise location of new work.

B. Backfill test pits as soon as desired information has been obtained. Maintain backfilled surface appropriate for travel until resurfaced.

3.6 EXCAVATION BELOW GRADE AND REFILL

A. Drain trench completely and effectively be in-the-dry, whatever the nature of unstable material encountered or groundwater conditions.

B. If Contractor excavates below grade through error or for their own convenience, through failure to properly dewater the trench, or disturbs subgrade before dewatering is sufficiently complete, the Engineer may direct Contractor to excavate below grade as set forth in following Paragraph, where work shall be performed at its own expense.

C. If material at trench bottom consists of fine sand, sand and silt or soft earth which may work into the screened gravel, even with effective drainage, remove subgrade material to extent directed. Refill excavation with a 6-inch layer of coarse sand or a mixture graded from coarse sand to fine pea stone to form a filter layer preserving voids in pipe gravel bed. Composition and gradation of gravel shall be approved by the Engineer prior to placement. Place screened gravel in 6-inch layers thoroughly compacted up to normal grade of pipe. If directed by the Engineer, use bank-run gravel for refill of excavation below grade.

3.7 BACKFILLING

A. Begin backfilling as soon as practicable after laying and jointing pipe and continue expeditiously. Place bedding gravel of specified type for pipe installed up to 12 inches over the pipe.

B. Construct an impervious dam or bulkhead cutoff of clay or other impervious material in the trench, as directed by the Engineer, to interrupt unnatural flow of groundwater after construction is completed. Key dam into trench bottom and sidewalls. Provide at least one clay or other impervious material dam in pipe bedding between each manhole where directed or every 300 feet, whichever is less.

C. Where pipes are laid cross-country, fill remainder of trench with common fill material in layers not to exceed 12 inches and mounded 6 inches above existing grade or as directed by the Engineer. Where a loam or gravel surface exists prior to cross-country excavations, remove, conserve and replace it to full original depth as part of the work under pipe items. Where necessary, remove excess material during clean-up process, so that ground may be restored to its original level and condition.

D. Where pipes are laid in streets, backfill remainder of trench up to a depth of **[**12 inches for State Highways**]** below bottom of specified permanent paving with select common fill material in layers not to exceed 12 inches and thoroughly compacted. Use bank-run gravel for subbase layer of paving and compact in 6 inches layers.

E. To prevent longitudinal pipe movement, do not dump backfill material into trench and then spread, until selected material or screened gravel has been placed and compacted to a level at least 12 inches over the pipe.

F. Bring backfill up evenly on all sides. Thoroughly compact each layer of backfill material by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping to 95 percent compaction according to ASTM D 1557. If rolling, use a suitable roller or tractor being careful to compact fill throughout full width of trench.

G. Do not compact by puddling or water jetting.

H. Use hand or pneumatic ramming with tools weighing at least 20 pounds for compacting in confined areas. Spread and compact material in layers not exceeding 6 inches thick, an uncompacted loose measurement.

I. Use granular fill material as backfill around structures. Spread and compact specified backfill under and over pipes connected to structures.

J. Do not place bituminous paving in backfill. Do not use frozen material under any circumstances.

K. Broom and hose-clean road surfaces immediately after backfilling. Employ dust control measures throughout construction period.

3.8 RESTORING TRENCH SURFACE

A. Where trench occurs adjacent to paved streets, in shoulders, sidewalks, or in cross-country areas, thoroughly consolidate backfill and maintain surface as the work progresses. If settlement takes place, immediately deposit additional fill to restore ground level.

B. In and adjacent to streets, 12 inches of trench backfill below specified initial pavement shall consist of compacted bank-run gravel. If Contractor wants to use material excavated from trench as gravel subbase for pavement replacement, take samples at intervals not to exceed 500 feet of material and test by an independent testing laboratory at Contractor’s expense. Use only materials approved by the Engineer.

C. Restore surface of driveways or other areas which are disturbed by trench excavation to a condition at least equal to that existing before work began.

D. In areas where pipeline passes through grassed areas, remove and replace sod or loam and seed surface at Contractor's own expense.

END OF SECTION 312333

SECTION 312500 - EROSION AND SEDIMENTATION CONTROLS

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. Rock Barriers/Check Dams
   2. Sediment Fences
   3. Construction Entrances
   4. Filter Bags
   5. Erosion Control Blanket

B. Related Sections:
   1. Section 310515 “Soils and Aggregates for Earthwork”
   2. Section 311000 - Site Clearing
   3. Section 312316 - Excavation
   4. Section 329200 - Turf and Grasses
   5. Section 329219 - Seeding and Soil Supplements
   6. Section 334213 - Pipe Culverts.

1.3 REFERENCE STANDARD

A. EPA document titled: “Stormwater Management for Construction Activities – Developing Pollution Prevention Plans and Best Management Practices” document number EPA 832-R-92-005, dated 1992, or most recent edition. State or appropriate Conservation Commission standards can be substituted for the EPA standard if the State or Conservation Commission standard is equal to, or more detailed than, the EPA standard.

1.4 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.
   1. Submit, within 10 days after award of Contract, technical product literature for all commercial products.

1.5 INFORMATIONAL SUBMITTALS

A. Stormwater Pollution Prevention Plan (SWPPP) as specified in “Quality Assurance” article.

B. Copy of EPA NPDES Notice of Intent to Discharge submitted to the EPA as specified in "Quality Assurance" article.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 "Closeout Procedures": Requirements for submittals.

1.7 QUALITY ASSURANCE

A. Prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) in accordance with the U.S. Environmental Protection Agency (EPA) National Pollution Discharge Elimination System (NPDES) General Permit applicable to this work) document number EPA 832-R-92-005, dated 1992, or most recent edition.

B. Prepare and submit the EPA NPDES Notice of Intent to Discharge to the applicable EPA office in accordance with EPA regulations.

C. Be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the Owner will be considered.

D. Perform Work according to the most recent edition of the Genesee County Drain Commissioner standard specifications and details for Soil Erosion and Sedimentation Control.

1.8 PRE-INSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 - PRODUCTS

2.1 AGGREGATE,

A. Coarse Aggregate: Type 6AA, Furnish according to MDOT standards.

2.2 SILT FENCE

A. Silt fence filter fabric shall be a woven, polypropylene, ultraviolent resistant material meeting minimum requirements below:

Fabric Properties	Minimum Acceptable Value	Test Method
Grab Tensile Strength (lbs)	110	ASTM D 4632/ D 4632M
Elongation at Failure (%)	20	ASTM D 4632/ D 4632M
Mullen Burst Strength	300 psi	ASTM D 3786/ D 3796M
Puncture Strength (lbs)	60	ASTM D 4833/ D 4833M
Minimum Trapezoidal Tear Strength (lbs)	50	ASTM D 4533/ D 4533M
Flow through Rate (gal/min/sf)	25	ASTM D 4491/ D 4491M
Equivalent Opening Size	40 – 80	US Std Sieve ASTM D 4751
Minimum UV Residual (%)	70	ASTM D 4355/ D 4355M

B. Products: Provide one of the following:
1. "Mirafi FW402," by TenCate Geosynthetics
2. "Carthage 15%," by Carthage Mills
3. "HSP2." by ACF Environmental, Inc.
4. Or equal.

C. Sediment fence shall be a prefabricated commercial product made of a woven, polypropylene, ultraviolet resistant material such as "Envirofence" by Mirafi Inc., Charlotte, NC or equal.

2.3 FILTER BAGS

A. Filter Bags: Sized with manufacturer recommendations based on pumped discharge rate.

B. Geotextile Material for Bags: Meet the following minimum requirements:

Minimum Grab Tensile Strength	200 lbs
Minimum Grab Tensile Elongation	50%
Minimum Trapezodial Tear Strength	80 lbs
Mullen Burst Strength	380 psi
Minimum Puncture Strength	130 lbs
Apparent Opening Size	40-80 US Sieve
Minimum Flow Through	70 gpm/square foot

C. Bag shall have opening large enough to accommodate 4 inch diameter discharge hose.

2.4 EROSION CONTROL BLANKET

A. Erosion control blankets: 100 percent agricultural straw fiber matrix, 0.5 lbs / sq yd, stitch bonded with degradable thread between two photodegradable polypropylene nettings.

1. Product: Provide Model S150 Double Net Short-Term Blanket (12 months) by North American Green, Evansville, IN), or equal.

B. Prior to start of work, provide a certified statement as to the number ofpoundsf materials to be used per 100 gallons of water. Specify the number of square feetof seeding that can be covered with the quantity of solution in the Contractor's hydroseeder.

2.5 PLANTING MATERIALS

A. Seeding and Soil Supplements: Furnish according to Genesee County Drainage Commissioner standard specifications.

B. Mulch: Furnish according to Genesee County Drainage Commissioner standard specifications

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Verification of existing conditions before starting work.

B. Verify compacted subgrade, granular base, or stabilized soil is acceptable and ready to support devices and imposed loads.

C. Verify gradients and elevations of base or foundation for other work are correct.

3.2 ROCK BARRIER

A. Determine length required for ditch or depression slope and excavate, compact and foundation area to firm, even surface.

B. Produce an even distribution of rock pieces, with minimum voids to the indicated shape, height and slope.

C. Construct coarse aggregate filter blanket against upstream face of rock barrier to the indicated thickness.

3.3 SILT FENCE

A. Position sediment fences as indicated on the Drawings and to prevent off site movement of sediment produced by construction activities as directed by the Engineer. Areas beyond limits of silt fence shall be undisturbed or stabilized.

B. Dig trench approximately 6 inch wide and 6 inch deep along proposed fence lines.

C. Drive stakes, 10 feet on center (maximum) at back edge of trenches. Drive stakes 2 feet (minimum) into ground.

D. Hang filter fabric on posts carrying to bottom of trench with about 4 inches of fabric laid across bottom of trench. Stretch fabric fairly taut along fence length and maintain secure both ways.

E. Backfill trench with excavated material and tamp.

F. Install pre-fabricated silt fence according to manufacturer's instructions.

3.4 CONSTRUCTION ENTRANCE

A. Construct entrance with minimum of 6 inch of course aggregate at all points of ingress/egress.

B. Width: Minimum 30 feet, increased as needed for typical construction vehicles.

C. Minimum Length: 100 feet

D. Install filter fabric below aggregate.

E. Maintain entrance throughout construction, adding more aggregate or increasing length as needed.

3.5 FILTER BAG

A. Locate filter bag at least 50 feet from all wetlands, streams or other surface waters.

B. Install bag on a 2 inch (50 mm) gravel bed to allow water to flow in all directions.

C. Bag is full when remaining flow area is reduced by 75%. Replace full bags with new bags.

3.6 EROSION CONTROL BLANKETS

A. Install erosion control blankets onto all exposed slopes to be loamed and seeded that are steeper than 4(Horizontal) to 1(Vertical) as shown on the Drawings. Erosion control blankets shall also be installed in all seeded drainage swales and ditches, and as directed by the Engineer in accordance with manufacturer's instructions.

B. The area to be covered shall be properly prepared, fertilized and seeded with permanent vegetation before the blanket is applied. When the blanket is unrolled, the netting shall be on top and the fibers in contact with the soil over the entire area. The blankets shall be applied in the direction of water flow and stapled.

C. Place blankets and stapled together in accordance with manufacturer's instructions. Side overlaps shall be 4-inch minimum. The staples shall be made of wire, 0.091 inch in diameter or greater, "U" shaped with legs 10-in in length and a 1-1/2-in crown. Commercial biodegradable stakes may also be used with prior approval by the Engineer. The staples shall be driven vertically into the ground, spaced approximately two linear feet apart, on each side, and one row in the center alternately spaced between each size. Upper and lower ends of the matting shall be buried to a depth of 4-in in a trench. In swales and ditches, erosion stops shall be created every 25-ft by making a fold in the fabric and carrying the fold into a silt trench across the full width of the blanket. The bottom of the fold shall be 4-in below the ground surface. Staple on both

sides of fold. Where the matting must be cut or more than one roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of 4-in. Overlap lower end of upstream roll 4-in past edge of downstream roll and staple

D. To ensure full contact with soil surface, roll matting with a roller weighing 100 lbs/ft of width perpendicular to flow direction after seeding, placing matting and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.EC blankets for bottom of swales and along edge of pathways.

3.7 SITE STABILIZATION

A. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

B. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

C. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2: 1 or flatter.

D. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.
   1. During non-germinating periods, apply mulch at recommended rates.
   2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 329219 at 60 percent of permanent application rate with no topsoil.
   3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 329219 permanent seeding specifications.

E. Stabilize diversion channels, sediment traps, and stockpiles immediately.

3.8 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements 017300 - Execution: Field inspecting, testing, adjusting, and balancing.

B. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order. If such inspection reveals that additional measures are needed to prevent movement of sediment to offsite areas, promptly install additional devices as needed. Sediment controls in need of maintenance shall be repaired promptly.

3.9 CLEANING

A. Section 017300 “Execution” and 017700 “Closeout Procedures”: Requirements for cleaning.

B. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

C. Do not damage structure or device during cleaning operations.

D. Do not permit sediment to erode into construction or site areas or natural waterways.

E. Clean channels when depth of sediment reaches approximately one half channel depth.

3.10 PROTECTION

A. Section 017300 “Execution”: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.

C. Do not permit construction traffic over paving for 7 days minimum after finishing or until75 percent design strength of concrete has been achieved.

D. Protect paving from elements, flowing water, or other disturbance until curing is completed.

END OF SECTION 312500

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SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

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 temporary excavation and trench support and protection systems.

B. Related Requirements:
1. Section 013233 "Photographic Documentation" for recording preexisting conditions and excavation support and protection system progress.
2. Section 014000 “Quality Requirements” for testing and laboratory services.
3. Section 310900 “Geotechnical Instrumentation and Monitoring” for monitoring equipment.
4. Section 312000 "Earthwork" for excavating and backfilling.
5. Section 311000 "Site Clearing" for site stripping, grubbing, stripping topsoil, and removal of above- and below-grade improvements and utilities.
6. Section 312316 “Rock Removal” for excavation of rock and boulders.
7. Section 312319 "Dewatering" for lowering and disposing of ground water during construction and dewatering excavations.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer, meeting the minimum performance requirements in Part 2 of this Section.
1. Include overall system plan, indicating clearances, dimensions, material properties, member sizes, locations, spacing and member penetrations depths, and locations of various types of lateral supports.
2. Show details, layout, arrangement, equipment requirements, and method of construction of proposed excavation support system.
3. Indicate existing and proposed utilities, structures or other obstructions.
4. Show wall elevations and locations of bracing.
5. Show overall installation sequence and removal of bracing. Indicate work levels to be performed before bracing is installed or removed.
6. Method of preloading bracing, if required, including preload for each member, and method of locking-off the preload. Submit detailed drawings of connections, jacking supports, and method of shimming.
   Include procedures for resolving difficulties arising from misalignment of members exposed during excavation and criteria for implementing those procedures. n.

B. Design Calculations: For excavation support and protection system. Include analysis data prepared, signed, and sealed by professional engineer responsible for their preparation.
   1. Include loads on excavation support system for all stages of excavation, bracing removal, and concrete placement, including material and equipment loads on adjacent ground during construction.
   2. Include design of wall and bracing members including details for all construction stages.
   3. Include theoretical deflections of excavation support system and deformation of structures, pipelines, and other improvements located within areas influencing excavations.

C. Submit to the Engineer for review, a plan of action to be implemented in the event any deformation threshold value is reached as specified in Section 310900 "Geotechnical Instrumentation and Monitoring." Identify positive measures in action plan to further limit wall movement, including but not limited to trenching for struts and wales, placement of granular earth berms against the wall, installation of additional struts, or combinations thereof.
   1. Include description and details of mitigating measures, work schedule, location and availability of materials, and structural details for connections to wall and support elements.
   2. Be prepared to work 24 hours per day to implement such measures.
   3. Perform remedial work and mitigating measures at no additional cost to Owner.

1.4 INFORMATIONAL SUBMITTALS

A. Submit quality control measures to ensure that performance of excavation support system complies with project requirements.

B. Submit welder qualifications and weld procedures in accordance with AWS D1.1.

C. Maintain at least one copy of design at job site during excavation that includes a plan indicating sizes, types, and configurations of the materials to be used in protective system. Identity registered Contractor's design engineer who stamped the design.

D. Do not proceed with excavation support or protection activities until submittals have been approved by the Engineer.

1.5 QUALITY ASSURANCE

A. Contractor Qualifications: Minimum 5 years' experience compatible to indicated Work, and who employs labor and supervisory personnel similarly experienced in Work of this Section.

B. Contractor's Design Engineer: Registered Professional Engineer in State were the work is located with at least 5 years' professional experience in design and construction of support of excavation systems and having completed a minimum of 5 successful excavation support projects of equal type, size, and complexity to specified work.

C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

D. Regulatory Requirements: Comply with authorities having jurisdiction, including OSHA requirements.

E. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent soil borings and tests, conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
   1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
   2. The geotechnical report is referenced elsewhere in Project Manual.

B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design**,** monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads within specified movement criteria (Section 310900 “Geotechnical Instrumentation and Monitoring”).
   1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems to minimize horizontal and vertical movements without damaging existing buildings, structures, and site improvements adjacent to excavation.
   4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

B. Do not permit excavations below the level of the base of adjacent existing foundations or retaining walls, unless excavation design and bracing includes an analysis of stability of structure supported by foundation and if necessary, incorporates required bracing or underpinning of foundation.

C. For support systems in which bracing is installed between opposite sides of the excavation, design excavation support of both sides to be nearly the same as feasible.

D. Where necessary to resist point loads, fill pipe piles used as soldier piles with concrete. Do not consider concrete strength in design of pipe pile for bending stress.

E. Design, install, operate, and maintain ground water control system to control ground water inflows, prevent piping or loss of ground, and maintain stability of the excavation. Refer to the requirements of Section 312319 “Dewatering.”

F. Design review and field monitoring activities by Owner or the Engineer does not relieve Contractor of its work responsibilities.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A36/A36M, ASTM A690/A690M, or ASTM A992/A992M.

C. Steel Pipe Used as Soldier Piling: ASTM A252, Grade 35 or better.

D. Steel Sheet Piling: ASTM A328/A328M, ASTM A572/A572M, or ASTM A690/A690M; with continuous interlocks.
   1. Steel sheet piling conforming to ASTM A572, Grade 50 or better.
   2. Corners: Site-fabricated mechanical interlock.

E. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of 4 inches with minimum allowable flexural strength of 1,100 psi.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that instrumentation required under Section 310900 “Geotechnical Instrumentation and Monitoring” is installed and initialized prior to start of work required by this Section.

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

3.2 PREPARATION

A. Obtain permits from local authority having jurisdiction prior to initiating excavation work.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

C. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

2. Install fencing, gates, lights, and signs around excavations and staging areas to provide for public safety.

D. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.3 GENERAL

A. Install excavation support systems in accordance with the shop drawings and applicable permits.

B. Fill voids between excavation support system and earth with materials acceptable to the Engineer.

C. If unstable material is encountered during excavation, take immediately measures to contain it in place and prevent ground displacement.

D. If settlement or deflections of supports indicate that support system requires modification to prevent excessive movements, redesign and resubmit revised shop drawings and calculations to the Engineer without additional compensation.

E. Maintain sufficient quantity of material on site for protection of work and for use in case of accident or emergency.

3.4 PORTABLE TRENCH BOXES

A. Use portable trench boxes or sliding trench shields only for worker protection.

B. Additional excavation, backfilling, and surface restoration required as result of trench box use shall be provided without additional compensation.

C. Design, construct, and maintain trench boxes or shields to meet acceptable engineering and industry standards.

D. Install shields in a manner to restrict lateral or other hazardous movement of the shield in the event of sudden lateral loads.

E. Maintain a written copy of trench box manufacturer's specifications, recommendations, and limitations at job site during excavation work.

3.5 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation.
   1. Install using impact hammer or vibratory hammer in predrilled holes.
   2. Soldier Piles in Predrilled Holes:
      a. Provide casing or other methods of support to prevent caving of holes and loss of ground.
      b. Backfill with concrete from elevation of bottom excavation to pile tip elevation. Backfill remainder of predrilled hole with lean concrete or sand.

c. Predrilled hole of sufficient diameter allowing for proper alignment and concrete backfilling of pile.

3. Install driven piles with driving shoes where hard driving is anticipated.
4. Advance driven soldier piles without aid of a water jet.

B. Extend soldier piles below excavation grade level to depths shown on reviewed Shop Drawings. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging.
1. Install lagging so ground loss does not occur between adjacent or below lowest board. As excavation proceeds, do not maximum height of 4 feet for unlagged face of excavation.
2. Do not exceed unlagged face of 2 feet, if water seeps or flows from excavation face or excavation face becomes unstable.

D. As installation progresses, pack voids between excavation face and lagging with materials such as hay, burlap, or geotextile filter fabric to allow drainage of ground water without loss of ground. Fill voids behind lagging with soil, and compact.

E. Install wales at locations indicated on Drawings and secure to soldier piles.

3.6 STEEL SHEET PILING

A. Thoroughly cleaned and inspect sheet piles for defects and proper interlock dimensions prior to installation. Provide a tool for checking interlock dimensions.

B. Before starting excavation, drive one-piece sheet piling lengths in plumb position and tightly interlock vertical edges for its entire length to form a continuous barrier. Form a continuous diaphragm throughout length of each run of wall, bearing tightly against original ground.
1. Exercise care in driving so interlocking members can be extracted without damaging adjacent structures or utilities.
2. Use driving, cutting, and splicing methods conforming to approved Shop Drawings.
3. Use templates or other temporary alignment facilities to maintain piling line.

C. Accurately place piling, using templates and guide frames unless otherwise recommended in writing by sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to [5 feet] . Accurately align exposed faces of sheet piling to vary not more than **2 inches** from a horizontal line and not more than 1:120 out of vertical alignment.

D. Install each sheet pile having sufficient clearance in interlocks to slide under its own weight into interlock of previously placed sheet pile.

E. Do not excavate in advance of steel sheet piling installation.

F. Remove obstructions encountered before the specified embedment for piles. Where obstructions cannot be removed, re-evaluate sheet pile system by Contractor’s design Engineer show reduced embedment and additional toe stability measures to be implemented for sheet pile wall realignment. Submittal proposed design measures to the Engineer for review.

G. Withdraw damaged or faulty aligned pilings with provide new piling, driven properly in its place without additional compensation.

H. Cut tops of sheet piling to uniform elevation at top of excavation.

3.7 INTERNAL BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
   1. Do not place bracing where it will be cast into or included in permanent concrete work, unless otherwise approved by the Engineer.
   2. Install internal bracing if required to prevent spreading or distortion of braced frames.
   3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

B. Provide internal bracing to carry maximum design load without distortion or buckling.

C. Include web stiffeners, plates, or angles required to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

D. Install and maintain bracing support members in tight contact with each other and with the surface being supported.

E. Coordinate excavation work with installation of bracing. Extend excavation no more than 2 feet below any brace level prior to installation of the bracing.

F. Use procedures that produce uniform loading of bracing member without eccentricities, overstressing, or distortion of system members.

3.8 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks weekly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.9 REMOVAL

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to

avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earthwork."
3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Do not remove vertical support members that were installed within zone of influence of new or existing structures. Cut off support members installed within this zone at 5 feet below finished grade and abandon in place.

C. Do not remove internal bracing or transfer loads to permanent structure without prior acceptance of the Engineer.

D. Begin removal at excavation bottom and progress upward. Slowly release members noting indication of possible failure of remaining members or possible cave-in of excavation sides.

E. Progress backfilling together with removal of support systems from excavations.

F. Remove all portions of excavation support, unless otherwise indicated by approved Shop Drawings.

1. Zone of Influence Definition: Zone extending down and away from outer edge of the structure at 1 horizontal to 1 vertical.

G. Do not leave wood as part of abandoned portion of the work.

H. When removing excavation support system, do not disturb or damage adjacent buildings, structures, waterproofing material, or utilities. Fill voids immediately with lean concrete or well-graded cohesionless sand or as directed by the Engineer.

I. Immediately remove excavation support system material from site.

END OF SECTION 315000

SECTION 321123 - AGGREGATE BASE COURSES

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: This specification describes the requirements for constructing an aggregate base under a proposed HMA surface. Work shall be completed in accordance with Section 302 of the 2012 Michigan Department of Transportation Standard Specifications for Construction.

A. Related Sections:
   1. Section 321216 - Asphalt Paving.
   2. Section 312000 - Earthwork

1.3 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:
   1. Submit initial aggregate test reports

C. Samples: Submit, in air-tight containers, 10 lb sample of each type of aggregate fill to testing laboratory.

D. Materials Source: Submit name of aggregate materials suppliers.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify products meet or exceed specified design requirements.
   1. Materials Resources Certificates:
      a. Certify source and origin for products.
      b. Certify recycled material content for recycled content products.
      c. Certify source for regional materials and distance from Project site.

1.5 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work according to State of Michigan Department of Transportation standards.

C. Soil and Aggregate Density Testing

1. Maximum Density of Granular Soils (loss by washing < 15%) and Aggregate

   The maximum density will be determined by the One Point Michigan Cone Test, as described in the Michigan Department of Transportation Density Testing and Inspection Manual.

2. Maximum Density of Cohesive Soils (loss by washing > 15%)

   The maximum density will be determined by the One Point T-99 Test, as described in the Michigan Department of Transportation Density Testing and Inspection Manual.

3. Density of In-Place Soils or Aggregate

   The in-place density of soils or aggregate will be determined by the Density In-Place (Nuclear) Test, as described in the Michigan Department of Transportation Density Testing and Inspection Manual.

PART 2 - PRODUCTS

2.1 MATERIALS

A.

A. Aggregate material for this project shall be 21AA Limestone. Aggregate shall meet the requirements of Series 21AA Limestone aggregate, as described in the 2012 Michigan Department of Transportation Standard Specifications for Construction, unless otherwise noted on the plans, proposal or specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Clean the underlying course or subgrade of all foreign substances prior to constructing the subbase base course(s).

B. Do not construct base/subbase course(s) on underlying course or subgrade that is frozen.

C. Prepare the surface of the underlying course or subgrade to meet specified compaction and surface tolerances.

D. Correct ruts or soft yielding spots in the underlying courses.

E. Correct areas having inadequate compaction, and deviations of the surface from the specified requirements:
   1. Loosen and remove soft or unsatisfactory material and add approved material.
   2. Reshape to line and grade.
   3. Recompact to specified density requirements.

F. For cohesion-less underlying courses or subgrades containing sands or gravels:
   1. Stabilize the surface prior to placement of the base course(s):
      a. Mix aggregate into the underlying course.
      b. Compact by approved methods.
      c. Do not allow traffic or other operations to disturb the finished underlying course.
      d. Maintain underlying course until the base course is placed.

G. Verify that the underlying surface has been inspected, gradients and elevations are correct.

3.2 FABRICATION

A. Place aggregate equal thickness layers to total compacted thickness within ½ inch (13 mm) of the thickness indicated on the drawings.
   1. Maximum lift Compacted Thickness: 6 inches.
   2. Minimum lift Compacted Thickness: 4 inches.

B. Level and compact the base course to within ½ inch of the thickness indicated.

C. Degree of Compaction:
   1. compact aggregate lifts to 98 percent of laboratory maximum dry density.
   2. Except as noted below, degree of compaction is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557.
   3. the degree of compaction for material having more than 30 percent by weight of their particles retained on the ¾ inch (19.0 mm) sieve will be expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

D. Maintain optimum moisture content of material as necessary to achieve the specified degree of compaction.

3.3 ERECTION TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Maximum Variation From Flat Surface: 1/4 inch measured with 10 foot straight edge.

C. Maximum Variation From Thickness: 1/4 inch.

D. Maximum Variation From Elevation: 1/2 inch.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements 017300 Execution: Field inspecting, testing, adjusting, and balancing.

B. Field Density Measurements: Measure field density in accordance with ASTM D1556/D1556M, ASTM D2167 or ASTM D6938.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests: One test for every 1000 square feet of each layer compacted aggregate.

END OF SECTION 321123

SECTION 321216 - ASPHALT PAVING

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. Asphalt materials.
2. Aggregate materials.
3. Aggregate subbase.
4. Asphalt paving base course, binder course, and wearing course.
5. Asphalt paving overlay for existing paving.
6. Surface slurry.

B. Related Requirement:
1. Section 321123 - Aggregate Base Courses: Compacted subbase for paving.
2. Section 330513 - Manholes and Structures

1.3 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:
1. Submit product information for asphalt and aggregate materials.
2. Submit mix design with laboratory test results supporting design.

C. Product information for aggregate materials, asphaltic concrete mix design, and prime and tack coats. Minimum information shall include source of aggregates and asphalt, gradation, unit weight of mix design, gradation, air void content, and other test results needed for comparison with MDOT Standard Specifications and field testing by Engineer.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to Michigan Department of Transportation Standards

B. Obtain materials from same source throughout.

C. Perform Work in accordance with MDOT Standards

D. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum _5_ years documented experience.

1.6 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.

B. Do not place asphalt mixture between November 1 and March 1.

C. Do not place asphalt mixture when ambient air or base surface temperature is less than [50] degrees F, or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall meet the requirements of Section 501.02 and 904 of the 2012 Michigan Department of Transportation Standard Specifications for Construction.

B. Bituminous mixtures and application rates shall be as shown on the plans.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Testing, inspection and analysis requirements.

B. Submit proposed mix design of each class of mix for review prior to beginning of Work.

C. Test samples in accordance with current MDOT Standards for Construction

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution”: Requirements for installation examination.

B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

C. Verify compacted subgrade and subbase is dry and ready to support paving and imposed loads.
   1. Proof roll subbase to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 312323.

D. Verify gradients and elevations of base are correct.

E. Verify manhole frames and valve boxes are installed in correct position and elevation.

3.2 PREPARATION

A. Prepare subbase in accordance with MDOT Standards

3.3 INSTALLATION

A. Subbase:
   1. Aggregate Subbase: Install as specified in Section 321123.

B. Primer:
   1. Apply primer on aggregate subbase at uniform rate of [1/2] gal/sq yd.

C. Tack Coat:
   1. Apply tack coat in accordance with MDOT Standards.

D. Double Course Asphalt Paving:
   1. Place asphalt binder course within 24 hours of applying primer or tack coat.
   2. Place binder course to thickness indicated on Drawings.
   3. Place wearing course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
   4. Place wearing course to thickness indicated on Drawings.
   5. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
   6. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.
   7. Install uniform thickness surface slurry over existing paving in accordance with ASTM D3910.
   8. Allow slurry to cure.
   9. Roll paving to achieve uniform surface.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4 inch.

D. Variation from Indicated Elevation: Within 1/2 inch.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting, testing.

B. Section 017300 “Execution”: Requirements for testing, adjusting, and balancing.

C. Take samples and perform tests in accordance with MDOT Standards

D. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

E. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving.

F. Asphalt Paving Density: ASTM D2950 nuclear method; test one location for every 1000 square yards compacted paving.

3.6 PROTECTION

A. Section 017300 “Execution”: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from mechanical injury for 24 hours or until surface temperature is less than 140 degrees F.

END OF SECTION 321216

SECTION 321623 - SIDEWALKS

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: Concrete paving for sidewalks.

B. Related Requirements:
1. Section 031000 - Concrete Forming and Accessories: Form materials, waterstops, and accessories.
2. Section 032000 - Concrete Reinforcing: Reinforcing steel and supports for cast-in-place concrete.
3. Section 033000 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on fill or grade, and other concrete components.
4. Section 079000 - Joint Protection: Sealant for joints.
5. Section 099000 - Painting and Coating: Pavement markings.
6. Section 321123 - Aggregate Base Courses: base course.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Section 012000 - Price and Payment Procedures: Contract Sum/Price modification procedures.

B. Sidewalks:
1. Basis of Measurement: By square yard.
2. Basis of Payment: Includes subbase, forms, reinforcing, concrete, accessories, placing, finishing, curing, and testing.

1.4 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit required information regarding concrete materials, joint filler, admixtures, and curing compounds.
2. Mix Design:
   a. Submit concrete mix design for each concrete strength prior to commencement of Work.
   b. Submit separate mix designs if admixtures are required for hot- and cold-weather concrete Work.
   c. Identify mix ingredients and proportions, including admixtures.
3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.

C. Samples: Submit two sample panels, illustrating exposed aggregate finish.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Source Quality-Control Submittals: Indicate results of tests and inspections.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement:
1. Submit qualifications for manufacturer and installer.

1.6 QUALITY ASSURANCE

A. Perform Work according to Sections 031000 - Concrete Forming and Accessories, 032000 - Concrete Reinforcing, and 033000 - Cast-in-Place Concrete.

B. Obtain cementitious materials from same source throughout.

C. Perform Work according to MDOT standards.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.9 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not place concrete if base surface temperature is less than 40 deg. F, or if surface is wet or frozen.

C. Subsequent Conditions: Maintain minimum 50 deg. F, for not less than 72 hours after placing, and at a temperature above freezing for remainder of curing period.

1.10 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 AGGREGATE SUBGRADE

A. As specified in Section 321123 - Aggregate Base Courses.

2.2 MATERIALS

A. Forms:
1. Description: As specified in Section 031000 - Concrete Forming and Accessories.
2. Height: Equal to full depth of finished sidewalk.

B. Reinforcement:
1. Reinforcing Steel and Wire Fabric: As specified in Section 032000 - Concrete Reinforcing.

C. Concrete:
1. Concrete Materials:
   a. As specified in Section 033000 - Cast-in-Place Concrete.
2. Cement:
   a. Comply with ASTM C150/C150M.
   b. Type: I - Normal portland.
   c. Color: White.
3. Fine and Coarse Aggregates:
   a. Comply with ASTM C33/C33M.

b. Class: 4S.
c. Coarse Aggregate Maximum Size: inch.

4. Exposed Aggregate:
   a. Washed natural limestone, furnished from single source.
   b. Color: As selected.
5. Water:
   a. Description: Potable.
   b. Comply with ASTM C94/C94M.
   c. Without deleterious amounts of chloride ions.
6. Air Entrainment: Comply with ASTM C260/C260M.
7. Chemical Admixtures:
   a. Comply with ASTM C494/C494M.
8. Fly Ash:
   a. Comply with ASTM C618.
9. Slag:
   a. Description: Ground-granulated blast-furnace slag.
   b. Comply with ASTM C989/C989M.
   c. Grade: 120.
10. Plasticizing:
    a. Comply with ASTM C1017/C1017M.
    b. Type: I - plasticizing.
11. Color Pigment:
    a. Comply with ASTM C979/C979M.
    b. Resistant to mineral oxides, alkalis, and fading.
    c. Color: As selected.

2.3 FABRICATION

A. Reinforcing:
   1. Comply with CRSI Manual of Practice.

B. Hooks:
   1. As indicated on Drawings.
   2. Type:
      a. Standard 90-degree bends.
      b. Seismic.

2.4 MIXES

A. Concrete:
   1. Mix concrete according to ACI 304 and deliver concrete according to ASTM C94/C94M.

2.5 FINISHES

A. Reinforcement:
   1. Galvanized Finish for Steel Bars:
      a. Comply with ASTM A767/A767M.
      b. Class: I.

c. Hot-dip galvanized after fabrication.
2. Epoxy-Coated Finish for Steel Bars: Comply with ASTM A775/A775M.
3. Epoxy-Coated Finish for Steel Wire:
a. Comply with ASTM A884/A884M.
b. Class A, using ASTM A775/A775M.

2.6 ACCESSORIES

A. Curing Compound:
1. Comply with ASTM C309.
2. Type: 1.
3. Class: A.

B. Joint Sealers:
1. Hot Applied:
a. Comply with ASTM D6690.
b. Type: II or III.

C. Cover Sheets:
1. Comply with ASTM C171, Type.
2. Burlap: Comply with AASHTO M182.

2.7 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Comply with ASTM C94/C94M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Requirements for installation examination.

B. Verify that compacted subgrade is dry and ready to support paving and imposed loads.

C. Verify that gradients and elevations of subgrade are as indicated on Drawings.

D. Verify reinforcing placement for proper size, spacing, location, and support.

3.2 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Moisten substrate to minimize absorption of water from fresh concrete.

C. Notify Engineer minimum 24 hours prior to commencement of concreting operations.

3.3 INSTALLATION

A. Subgrade:
   1. As specified in Section 321123 - Aggregate Base Courses.
   2. Comply with MDOT standards.

B. Forms:
   1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
   2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
   3. Clean forms and coat with form oil each time before concrete is placed.

C. Reinforcement:
   1. Place reinforcing at mid-height of paving.

D. Placing Concrete:
   1. As specified in Section 033000 - Cast-in-Place Concrete.

E. Joints:
   1. Place continuous transverse expansion joints at 5-foot intervals or width of sidewalk, whichever is less.
   2. Filler:
      a. Place joint filler between paving components and building or other appurtenances.
      b. Recess top of filler 1/4 inch for sealant installation.
   3. Provide sawn joints at 3-foot intervals between sidewalks and curbs.
   4. Provide keyed joints as indicated on Drawings.

F. Exposed Aggregate:
   1. Apply surface retarder where exposed aggregate finish is required.
   2. Wash exposed aggregate surface with clean water and scrub with stiff bristle brush, exposing aggregate.

G. Finishing:
   1. Light broom to-inch radius, and trowel edges of joints.
   2. Place curing compound on exposed concrete surfaces immediately after finishing.
   3. Edges and Joints:
      a. Edger Radius: 1/8 inch.
      b. Spalled Corners and Edges: Clean and fill with mortar mixture and finish.

H. Curing:
   1. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
   2. Mats:
      a. Cover exposed surface with two or more layers of wetted burlap, overlapping each other minimum 6 inches.
      b. Maintain burlap continuously saturated and in contact with concrete for minimum

I. Backfilling: After curing, backfill, grade, and compact adjacent disturbed area as indicated.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Maximum Variation of Surface Flatness: 1/4 inch in 10 feet.

C. Maximum Variation from True Position: 1/4 inch.

D. Line and Grade for Forms: 1/8 inch in any 10-foot-long section.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017300 - Execution: Requirements for testing, adjusting, and balancing.

C. Inspection and Testing:
   1. Comply with ASTM C94/C94M.
   2. Comply with MDOT standards.
   3. Samples:
      a. Sampling Procedures: Comply with ASTM C172/C172M.
      b. Cylinder Molding and Curing Procedures: Comply with ASTM C31/C31M, standard cured.
      c. Sample concrete and make one set of three cylinders for every 75 cu. yd. or less of each class of concrete placed each day, and for every 5,000 sq. ft. of surface area paving.
      d. Make one additional cylinder during cold-weather concreting, and field cure.
   4. Cylinder Compressive Strength:
      a. Comply with ASTM C39/C39M.
      b. Acceptance:
         1) Average Compressive Strength of Three Consecutive Tests: Maximum 500 psi less than specified compressive strength.
   5. Slump, Temperature, and Air Content:
      a. Measure for each compressive-strength concrete sample.
      b. Slump: Comply with ASTM C143/C143M.
      c. Air Content: Comply with ASTM C173/C173M.
      d. Temperature: Comply with ASTM C1064/C1064M.
   6. Records:
      a. Maintain records of placed concrete items.
      b. Record date, location of pour, quantity, air temperature, number of test samples taken.

3.6 PROTECTION

A. Section 017300 - Execution: Requirements for protecting finished Work.

B. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, rain and flowing water, and mechanical injury.

C. Do not permit traffic over paving for minimum 7 days after finishing.

D. Damaged Concrete:
   1. Remove and reconstruct concrete that has been damaged for entire length between scheduled joints.
   2. Refinishing damaged portion is not acceptable.
   3. Dispose of damaged portions.

3.7 ATTACHMENTS

A. Concrete Sidewalks: 3000-psi 28-day concrete, 4 inches thick, buff color portland cement, exposed aggregate finish.

END OF SECTION 321623

SECTION 329200 - TURF AND GRASSES

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. Seeding.
   2. Hydroseeding.
   3. Turf renovation.
   4. Erosion-control material(s).

B. Related Requirements:
   1. Site Clearing including grubbing and stripping is included in Section 311000
   2. Earthwork including excavation, backfill, fill and grading including the stockpiling of topsoil is included in Section 312000
   3. Erosion and Sedimentation Control is included in Section 312500.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

1.4 PRE-INSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification of each seed mixture for turfgrass, sod or plugs. Include identification of source and name and telephone number of supplier.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
   1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
   2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the National Association of Landscape Professionals:)
      a. Landscape Industry Certified Technician - Exterior.
      b. Landscape Industry Certified Lawn Care Manager.
      c. Landscape Industry Certified Lawn Care Technician.
   5. Pesticide Applicator: State licensed, commercial.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in the Turfgrass Producers International's (TPI) "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

C. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
1. Spring Planting: April 1 – May 20.
2. Fall Planting: August 10- October 1.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with Association of Official Seed Analysts (AOSA's) "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:
1. Quality: State-certified seed of grass species as listed below for solar exposure.
2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:

3. Full Sun: Bermudagrass (Cynodon dactylon).
4. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
5. Sun and Partial Shade: Proportioned by weight as follows:
   a. 50 percent Kentucky bluegrass (Poa pratensis).
   b. 30 percent chewings red fescue (Festuca rubra variety).
   c. 10 percent perennial ryegrass (Lolium perenne).
   d. 10 percent redtop (Agrostis alba).
6. Shade: Proportioned by weight as follows:
   a. 50 percent chewings red fescue (Festuca rubra variety).
   b. 35 percent rough bluegrass (Poa trivialis).
   c. 15 percent redtop (Agrostis alba).

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Composition: <enter percent> percent nitrogen, <enter percent> percent phosphorous, and <**enter percent**> percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.

C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 50 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

E. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

G. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

2.5 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

C. Erosion-Control Mats: Cellular, nonbiodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 6-inch nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel,

paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
3. Uniformly moisten excessively dry soil that is not workable, or which is dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LIMING AND FERTILIZING

A. Apply lime at application rate recommended by soil analysis.

B. Work lime into top 6 inches of soil.

C. Apply fertilizer at application rate recommended by soil analysis.

D. Apply fertilizer after smooth raking of topsoil and prior to installation of sod.

E. Apply fertilizer no more than 48 hours before laying sod.

F. Mix fertilizer thoroughly into upper 4 inches of topsoil.

G. Lightly water soil to aid dissipation of fertilizer.

3.4 TURF AREA PREPARATION

A. Topsoil Stripping:

1. Prior to performing any excavation, filling, grading or other earthwork; the Contractor shall strip and stockpile topsoil for later use on the project. Excess topsoil shall not be removed from the project site unless specifically provided elsewhere in the Contract Documents.

B. Finish Grading:
   1. The areas that are to be seeded shall be properly graded, sloped, and shaped with an allowance for the thickness of the topsoil layer. The earth bed upon which topsoil will be placed shall be friable to a depth of at least four inches. Earth beds not in a friable condition shall be harrowed with a disk, spring tooth drag, or similar equipment.

C. Placement and Preparation of Topsoil:
   1. Topsoil shall be spread on the prepared areas to a depth of three inches (in place, after rolling or compaction), unless otherwise shown on the plans or proposal. After spreading, any large clods or lumps shall be broken and all stones larger than 1 inch diameter, rocks, roots, litter, and other foreign debris shall be raked up and disposed of by the Contractor. After spreading and raking, the topsoil surface shall be in a friable condition and the surface shall be reasonably close to the proposed grades and cross section.
   2. The topsoil surface shall be shaped to provide proper drainage. Where proposed grades are not shown on the plans, the topsoil surface shall be graded to provide a smooth transition between the new construction and the existing, adjacent ground.
   3. Excess topsoil shall be stockpiled in a location acceptable to the Owner and neatly trimmed to present a neat appearance.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" Article.

B. For erosion-control mats, install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of erosion-control mat with planting soil and compact before planting.

D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft.

C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
2. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.7 HYDROSEEDING

A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.
3. Spray-apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry coat at a rate so that mulch component is deposited at not less than 500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate. Apply slurry cover coat of fiber mulch (hydromulching) at a rate of 1000 lb/acre.

3.8 TURF RENOVATION

A. Renovate existing turf where indicated.

B. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   2. Install new planting soil as required.

C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

D. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing turf.

F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply seed and protect with straw mulch as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.9 TURF MAINTENANCE

A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow Kentucky bluegrass to a height of 1-1/2 to 2 inches.

D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.10 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Engineer:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
   2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
   3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.
   4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.13 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
   1. Seeded Turf: 60 days from date of Substantial Completion.
      a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

B. Meadow Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Meadow Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.
   1. Maintenance Period: 60 days from date of Substantial Completion.

END OF SECTION 329200

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SECTION 330130.16 - TV INSPECTION OF SEWER PIPELINES

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. Assess the condition of the indicated, storm, and/or sanitary gravity sewer pipes.
   2. Closed-circuit television (CCTV) of selected gravity sewer pipes using the National Association of Sewer Service Companies (NASSCO) industry standard Pipeline Assessment and Certification Program (PACP) forms and coding.
   3. Creation of a digital submission of sewer inspection data, videos, photos, and reports on portable external hard drives.
   4. Provide a visual and written record of internal pipeline features including, general information, overall condition, wastewater depth, structural integrity and significant defects.

B. Related Requirements:
   1. Section 330130.41 “Cleaning of Sewers”

C. TV Inspection of Sewer Pipelines:
   1. Basis of Measurement: By linear foot, measured.
   2. Basis of Payment: TV inspection, data compiling according to NASSCO PACP standards, and audio-video recording of pipeline.

1.3 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

1.4 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 SCHEDULING

A. Section 013100 - Project Management and Coordination: Requirements for scheduling.

B. Schedule Work of this Section to coincide with sewer cleaning.

1.6 SEQUENCING

A. Section 011000 – “Summary: Requirements for sequencing.

B. Sequence Work in following order:
   1. Clean & TV Existing sanitary sewer(s) as shown on drawings to confirm an acceptable sanitary outlet is available for the proposed sanitary lead for Chemical Systems Feed Building.
   2. Confirm results with Engineer prior to starting work on Chemical Systems Building.

1.7 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Data:
   1. Database structure and file naming plan
   2. External Hard Drives become property of the City of Flint.
   3. Sewer Assessment Reports

C. Assessment Procedures Plan
   1. Pipeline assessment plan
   2. List of equipment to be used on the project, including product literature for all video equipment (including cabling, camera, footage counter, tilting device, and recorder)

D. Qualification Statements

1.8 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Prior to beginning assessment work, submit the following to the Engineer in accordance with Section 013300 Submittals:
   1. Qualifications statement in accordance with section 14000 Quality Requirements.

B. Traffic Control plan for work in areas of vehicular travel.

C. List of Project staff, including qualifications of Crew Chief and CCTV operator.

D. Spill plan to address any spills that might occur.

E. Two copies of the NASSCO-issued “certified PACP user” identification card showing certification number for each CCTV operator that will be performing assessment work on the Project. Work shall not commence until such certification is provided.

F. Confined Space entry and hazardous atmosphere training certifications for all staff that will be involved in work located within or near manholes.

1.9 QUALITY ASSURANCE

A. Perform Work according to NASSCO PACP standards, latest version.

1.10 QUALIFICATIONS

A. Contractor: Successfully performed work on at least ten other projects within the last five years that include at least 1,00,000 linear feet of CCTV video experience in NASSCO PACP format in gravity sewers 8-inches in diameter or greater.

B. CCTV Operator: Successfully performed work on at least three other projects within the last five years that includes at least 250,000 linear feet of CCTV video experience in gravity sewers using NASSCO PACP format.

C. Crew Chief: Minimum of five years of experience on projects involving the assessment of gravity sewer measuring 8 inches in diameter or greater and experienced in using the proposed equipment

PART 2 - PRODUCTS

2.1 EXTERNAL HARD DRIVES

A. Description: A portable storage device that can be attached to a computer through a USB connection.

B. Solid state data storage devices are preferred.

2.2 CCTV SOFTWARE

A. Capable of providing complete survey reports in compliance with the most recent version of NASSCO PACP.

B. The PACP defect and construction codes shall be pre-programmed in the CCTV software and shall be grouped by PACP Groups.

C. Software and Databases
1. Fully compliant with PACP.
2. Capable of customization with the ability to modify or add to the pipe line condition and group them for ease of use.
3. Assessment and reporting software program shall be menu-driven and shall have a complete on-screen help file.
4. NASSCO PACP mandatory fields and any additional available field requested by the Owner or Engineer shall be setup in the software prior to the assessment, and all of these fields shall be populated with information collected during the assessment. Any general and pipe segment information that is already known prior to the assessment shall be entered into the appropriate fields in advance of performing the physical assessment.
5. Maintain a database of underground pipe and manhole assets. Structure the asset database similar to the one referencing pipe usage (i.e., sanitary, storm, drainage, etc.) sections (i.e., projects, areas, quadrants).
6. Surveys include a method of pipe segment numbering and a chronological survey set-up numbering system.
7. Capacity to import and export survey results in the most recent NASSCO PACP exchange format.

D. The footage reading from the camera equipment shall be automatically entered into the survey log and shall directly correspond to the noted observation location throughout the pipe graphical and tabular reports generated.

2.3 SEWER ASSESSMENT REPORTS

A. File Naming Conventions: Name all files in accordance with the requirements of the Owner and Engineer to allow direct linking of files to pipe assets using a common unique identifier.
   1. Each manhole has been given a unique manhole identification (Asset ID) the file name for each pipeline assessed shall be that unique upstream manhole Asset ID followed by an underscore followed by the unique downstream manhole such as 0123S0456_0123S0457.pdf.
   2. If an unnamed manhole is found, the letter "A" shall be added to the end of the upstream manhole's Asset ID to form a new Asset ID. The data/video files shall then be renamed to include the new Asset ID and a new CCTV assessment shall be started from the new Asset ID.
   3. If more than one unnamed manhole is found between two named manholes, subsequent new manhole Asset IDs shall be formed using the letters "B", "C", etc.
   4. If an unnamed manhole is found, provide documentation showing the location of the unnamed manhole to the Owner and Engineer depicting the change in connectivity found in the field.
   5. If the contractor performs a reverse setup and televises an individual pipe segment from more than one direction (i.e. the camera is only able to televise a portion of the entire segment heading downstream, and the remaining portion of the pipe segment was televised heading upstream) then two or more separate video files are allowable. The name of the additional database files etc. (i.e. unique manhole Asset ID followed by an underscore followed by the unique downstream Asset ID) followed by "_1", "_2" etc. at the end of the filename so that it is clear there are multiple files and videos for the same pipe segment. If unnamed manhole(s) is (are) found the procedure previously described shall also apply. Examples:
      a. Initial filename: 0015S0001_0015S0002
      b. Additional filenames: 0015S0001_0015S0002_1
         Base the name of each digital still photo on the video/data filename of the specific sewer in which the photo was taken. Record the name as the video/data filename followed by the PACP code for the item pictured followed by the footage at which the observation was encountered. Examples:
      c. (Filename) (PACP Coded)@(footage).jpg
      d. 0015S0001_0015S0002_HSV@37_2.jpg
      e. 0015S0001_0015S0002_1_MCU@113_6.jpg

B. Format all data files to facilitate upload into a NASSCO PACP exchange database.

C. Digital Video: CCTV assessments shall be captured at a minimum video bit rate of 4,500 kbps.

D. Indicate individual survey results in tabular form and provide a sortable list of surveys based on a user-defined description field. Include the starting and ending manhole Asset IDs depths, pipe material, total survey length, and pipe diameter. All reports and and/or submittals shall comply with the most recent version of NASSCO PACP standards.

E. Submit assessment data to the Engineer on a weekly basis; including digital videos, digital photos, and evaluation reports, all in electronic format on portable external hard drive. All hard drives and the information contained within them are the property of the Owner after submittal.
   1. Fill data on each portable external hard drive to minimize the number of hard drives submitted. The hard drives shall contain separate digital files for each manhole-to-manhole section of pipe assessed.

2. Sections of a single segment of sewer shall not be recorded to more than one hard drive.
3. Video footage of recorded segments shall be grouped by area and shall be submitted in sequential order relating to the area mapping designation.
4. The footage counter reading from the camera shall appear on all videos.
5. Separate folders shall be created on the external hard drives for assessment data, digital videos, digital photos, evaluation reports, supporting documentation etc. so all submittals of the same type are in a single folder.
6. Separate subfolders shall not be used be used to separate submittals of the same type under the main folder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution”: Requirements for application examination.

B. Field verify location of sewer pipelines to be inspected.

3.2 PREPARATION

A. Section 017300 “Execution”: Requirements for application preparation.

B. Sewer Flow Control
1. Evaluate each segment of sewer to be assessed with respect to diameter, flowrate, velocity, upstream/downstream manhole diameter, debris levels, extent of pipe wall corrosion, and accessibility. Select and provide the most appropriate equipment and methods based on the condition of the specific sewer line segment and its access manhole(s) at the time the work commences.
2. All assessment work shall be attempted during periods of low flow in the sewer segments being assessed.
3. At all times during the assessment, the flow in the sewer line segment(s) being assessed shall be suitably controlled as needed to perform the assessment.
4. If the depth of flow in the sewer segments to be assessed is above the maximum allowable for the use of standard CCTV equipment, use of floating inspection equipment can be used.
5. If the depth of flow in the sewer segments to be assessed is above the maximum allowable for the use of floating inspection equipment, off peak hours should be pursued to perform the assessment. If flow levels are not sufficient during off peak hours, the flow level shall be lowered by either:
    a. using flow through plugs
    b. performing bypass pumping as approved by the Engineer.
6. When flow in a sewer line is plugged, blocked, or bypassed, take precautions:
    a. to protect the sewer lines from damage that might result from sewer surcharging.
    b. to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewer involved.

C. The equipment and methods used for each sewer pipe and the setup location shall conform to the submitted and reviewed plan.
1. Standard CCTV equipment is appropriate for sewer segments that:
    a. Have a depth of flow less than 25 percent of the pipe diameter.

b. Do not have signs of corrosion.
c. Do not appear to have significant debris accumulation below the water surface.

2. Floating HD Image equipment is appropriate for sewer segments that:
   a. Do not meet the previously-listed conditions for using standard and CCTV equipment.
   b. Require longer continuous lengths of assessment due to the difficulty of the manhole access or connection to a buried manhole or manholes.

D. Perform sewer line cleaning in accordance with Section 330130.41 “Cleaning of Sewers” to provide a thorough assessment of the sewer condition.

3.3 APPLICATION

A. CCTV Equipment
1. Provide a mobile vehicle large enough to accommodate at least three people with video monitoring equipment specifically compatible with the camera equipment being used. Owner and Engineer shall have unrestricted access to observe the television screen and all other operations.
2. CCTV Camera:
   a. designed and constructed for such assessment and shall be
   b. capable of producing digital still photos of all sewer observations and service connections.
   c. adjustable light source generate an even distribution of lighting for the camera that results in a clear color picture of the entire periphery of the pipe.
   d. Operable in 100 percent humidity conditions and in a hazardous and corrosive environment.
   e. Provide a backup (spare) camera either on the Project site or at a nearby location so performance of the Work is not delayed.
   f. When usage of standard CCTV equipment is not feasible due to access issues, pipe condition, and/or depth of water flow, floating camera equipment may be used.
   g. Capable of panning 360 degrees and tilting 270 degrees and with minimum optical zoom ratio of 10:1 plus a minimum digital zoom ration of 4:1 to facilitate the assessment of all laterals and defects with optimum picture quality provided by focus and iris adjustment.
3. Floating HD Camera: the camera shall be capable of recording 360 degree view using a fisheye lens without tilting or panning.
4. CCTV Equipment:
   a. Camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction pf the Owner and/or Engineer. Picture resolution shall be a minimum of 460 television lines (TVL).
   b. Provide a lighting system adequate for quality pictures. A reflector in front of the camera may be required to enhance the lighting in black pipe.
   c. Accurate footage counter to display on the monitor the exact distance of the camera from the centerline of the starting manhole.
   d. Compatible with the version of NASSCO PACP used by the CCTV software and the reports and submittals generated from the software.

3.4 FIELD QUALITY CONTROL

A. The following measurements shall be collected for each accessible manhole and included in the PACP exchange database:

1. Utilize GPS equipment to obtain X and Y state plane coordinates with a submeter accuracy.
2. Field-measure the vertical distance from the top of the manhole frame to the invert in accordance to NASSCO PACP standards.

B. Pipeline Assessment:
1. Each sewer section shall be assessed from the upstream manhole to the downstream manhole if possible.
2. For the upstream and downstream manholes on each segment of pipe that is assessed, pan and tilt from the invert and take digital still photos that clearly depict the entirety of the manhole interior, including cone section.
3. Assess the full length of each sewer between access points. When the camera is unable to pass an obstruction even though flow is continuing, perform a reverse setup of the CCTV equipment from the opposite access point.
4. Perform all CCTV assessments using personnel who are trained and certified (current standing) in the use of NASSCO's PACP.
5. Multiple upstream and/or downstream sewer segments can be televised from a single manhole setup location as long as each manhole to manhole video section restarts its footage counter at zero and a separate video file for each assessment is submitted.
6. The CCTV camera shall travel through the lines using its own power unless a tethered floating unit is used. The pictures taken of the entire inside periphery of the pipe shall be clear and visible. Picture quality and definition shall be to the satisfaction of the Engineer.
7. Stop the camera at all service laterals and pan at such an angle that an internal view of the service lateral is available to determine if the lateral is active, inactive, or plugged. Take photos:
    a. include a brief description of the subject of the photo directly on the photo.
    b. catalogue and link in the CCTV database so the photos correspond with the length along the sewer line where the photo of the recorded observation was taken.
    c. JPEG format and at least 50 kilobytes in size.
8. Adjust the camera height such that the camera lens is always centered in the pipe being televised.
9. Retrieve camera equipment that becomes stuck within a sewer.
10. Submit CCTV inspection videos, where reversal setups are not required, in one continuous video section from manhole to the immediately adjacent manhole and not in multiple files. If a reverse setup is required, two complete inspections and video are acceptable.

C. Calibrate camera footage on a weekly basis in the presence of the Owner or Engineer with an above ground tape measure and simultaneous CCTV footage counter.

D. Project Notifications: Notify the Engineer and the owner immediately if:
1. A collapsed pipe or other significant pipe failure is discovered.
2. The conditions for CCTV assessment are found to be unsafe or impractical.
3. A manhole is buried, cannot be found, or cannot be accessed. Include a diagram in PDF file format that clearly indicates the location of the manhole, identifies its Asset ID, and lists the procedures that were used to attempt to locate the manhole.
4. Any defects that pose immediate danger to the public are observed (i.e. missing or broken manhole covers, sinkholes, etc.).
5. Any major pipe blockages, manhole surcharging, or potential overflow conditions are observed.

6. The pipe configuration in the field is different than shown on the Drawings. Include a diagram in PDF file format that clearly indicates the location of structures in relation to immediately adjacent structures.
7. Any significant obstructions are found within permanent sewer easement, even if these obstructions do not impact the Work.

3.5 DATA QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.
   1. Engineer requires a 30-day period to review sewer assessment data/videos after each submittal has been received.
   2. Payment applications will not be processed until the sewer assessment data/videos have successfully passed the quality review and have been accepted by the Engineer.
   3. Additional 30-day review periods apply to each resubmittal of data/videos determined to be unacceptable by the Engineer.
   4. Re-inspection is required when digital videos are inaccurate or of such poor quality that the Engineer is unable to evaluate the condition of the sewer or locate sewer service connections.
   5. Provide CCTV assessment data contained on each portable external hard drive in the most recent version of PACP exchange format. Include video indexing for all observations. CCTV assessment data to be submitted:
      a. Database file
      b. Still photos in JPEG file format for each observation
      c. Video for each inspection in MPEG1 file format.
      d. Summary report for each pipe segment in PDF format.

END OF SECTION 330130.16

SECTION 330130.41 - CLEANING OF SEWERS AND MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cleaning of sewer pipe and fittings installed and/or rehabilitated, complete as shown on the Drawings and as specified herein.

B. Cleaning includes proper high-pressure water jetting, rodding, bucketing, brushing and flushing of sewers and manholes prior to inspection by closed circuit television, pipeline rehabilitation or replacement, point repairs, manhole preparation, and testing operations.

C. Clean all sewers to remove debris, roots, intruding services, deposits, and other blockages to a minimum of 95 percent open. Perform sewer cleaning work to an acceptable level as necessary to perform a thorough television inspection of sewer. If pipe condition is such that cleaning may cause a potential collapse, then pipe shall be televised without attempting to clean it to 95 percent condition, pending approval by Engineer.

D. Related Requirements:
   1. Section 330130.16 - TV Inspection of Sewer Pipelines

1.2 DEFINITIONS

A. Light Cleaning: Small amounts of debris existing within sewer line and where sewer reaches do not require heavy cleaning, as defined below, and that produce little or no debris.

B. Heavy Cleaning: Large deposits of debris or heavy root growth existing within sewer line and where sewer reaches require debris removal of depths up to 25 percent of pipe height.

C. Excessive Heavy Cleaning: Large deposits of debris or heavy root growth existing within sewer line and where sewer reaches require debris removal exceeding the definition of Heavy Cleaning, and time required to clean and inspect the line must be at least twice the average time required to clean and inspect other sewers of comparable length and diameter.

1.3 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Section 012000 - Price and Payment Procedures: Contract Sum/Price modification procedures.

B. Light Cleaning: Clean sewer using standard industry procedures of high pressure water jetting equipment or other approved equipment. Costs related to cleaning of such sewers shall be included in Contractor’s unit prices for CCTV and Heavy Cleaning.
   1. Basis of Measurement: By linear foot,

2. Basis of Payment: TV inspection, data compiling according to NASSCO PACP standards, and audio-video recording of pipeline.

C. Heavy cleaning: Heavy cleaning must be approved by Engineer. Include costs related to cleaning of such sewers in Unit Prices for Heavy Cleaning. Costs related to televising of such sewers following heavy cleaning shall be included in Unit Prices for CCTV and Heavy Cleaning. Compensation for heavy cleaning of a particular line will only be paid if:
1. Heavy cleaning was authorized by Engineer prior to performance of the work.
2. Contractor proves that both significant time and effort was necessary to clean the line, (i.e. time required to clean and inspect the line must be at least twice the average time required to clean and inspect other sewers of comparable length and diameter.
3. Adequate video proof of 'before' blockage, debris, grit or grease build-up, or other condition is provided.
4. A submerged camera does not justify a need for heavy cleaning; proof that submergence was due to a blockage or heavy debris and not a sag in the line will be required.
5. Heavy Cleaning will be paid for on a lineal foot basis only for length required to be cleaned, i.e., from downstream manhole to approximate location of heavy cleaning. This may or may not include entire pipe section, unless otherwise approved by Engineer or Owner.
6. Basis of Measurement: By linear foot, measured.
7. Basis of Payment: TV inspection, data compiling according to NASSCO PACP standards, and audio-video recording of pipeline.

D. Excessive Heavy Cleaning: Pipes that contain excessive blockages will be paid on a time and material basis, upon approval by Engineer. A full-time inspector is required to oversee time and material work. Provide direct water source as required. Engineer or Owner may determine any individual pipe be cleaned on a time and material basis.

1.4 INFORMATIONAL SUBMITTALS

A. Section 013300 - Submittal Procedures specifies requirements for submittals.

B. Submit a safety plan prior to performing any on-site work that includes the following as a minimum:
1. Confined Space Entry.
2. Personal Protective Equipment.

C. Qualifications Statements:
1. Contractor shall have a minimum of five years' experience in sewer line and underground structure cleaning. Submit a list of at least three customers who have had similar work complete. Furnish trained and qualified technicians with proper experience operating equipment that is being used on this project.

1.5 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures specifies requirements for submittals.

B. Submit one complete set of documentation regarding inspections and work performed. Based on work scope, submit written reports, photographs and External Hard Drives that incorporate color video and data per Section 330130.16 - TV Inspection of Sewer Pipelines.

PART 2 - PRODUCTS

A. NOT USED

PART 3 - EXECUTION

3.1 Remove debris, roots, intruding services, deposits, and other blockages to a minimum of 95 percent open as necessary to perform a thorough television inspection of sewer. If pipe condition is such that cleaning may cause a potential collapse, televise pip without attempting to clean it to 95 percent condition, pending approval by Engineer.

3.2 PREPARATION

A. Section 017300 - Execution specifies requirements for installation preparation.

B. Select, based on pre-construction CCTV inspection, cleaning equipment to address conditions of manhole and sewer lines at the time the work commences to adequately remove dirt, grease, rocks, sand, and other materials and obstructions from sewer lines and manholes to allow performance of other work.

C. Take satisfactory precautions to protect sewer lines from damage that might be caused by improper use of cleaning equipment. Whenever using hydraulically propelled cleaning tools that depend upon water pressure to provide their cleaning force, or any tools that retard flow of water in sewer line, take precautions to ensure that water does not cause damage or flooding to public or private property.

D. No fire hydrant shall be obstructed in case of a fire in area served by hydrant.

E. Remove water meters, piping, and related equipment from fire hydrants at end of each work day.

3.3 EQUIPMENT

A. Hydraulic Sewer Cleaning Equipment:
   1. Equipment: movable dam type constructed so that a portion of the dam may be collapsed at any time during cleaning operation to protect against flooding of sewer.
      a. Movable dam shall be same diameter as pipe being cleaned and shall provide flexible scraper around outer periphery to ensure total removal of grease. If sewer cleaning balls or other such equipment which cannot be collapsed instantly are used, take special precautions against flooding of sewers and public or private property.

B. High Velocity Jet (Hydrocleaning) Equipment:
   1. Have a minimum of 500 feet of high pressure hose.
   2. Have a selection of two or more velocity nozzles that are capable of producing a scouring action from 15 to 45 degrees in all size lines to be cleaned. Also include a high velocity gun for washing and scouring manhole walls and floor.
   3. Be capable of producing a minimum of 80 gallons per minute flows from a fine spray to a long distance solid stream and delivering up to 1000 psi. Be able to carry its own water tank, auxiliary engines, pumps, and hydraulically driven hose reel. Locate controls so equipment can be operated above ground. Select flowrates and pressures as required for each size of sewer, type of debris, and amount of debris, and as recommended by nozzle manufacturers.
   4. Have a water tank, auxiliary engines and pumps, and a hydraulically driven hose reel.
   5. Have root cutting blades that are hydraulically spun.

C. Mechanical Cleaning Equipment:
   1. Bucket machines shall be in pairs and with sufficient power to perform the work in an efficient manner. Machines shall be belt operated or have an overload device. Machines with direct drive that could cause damage to the pipe shall not be acceptable.
   2. Power rodding machines shall be either sectional or continuous type capable of holding a minimum of 750 feet of rod. Rod shall be specifically treated steel. To ensure safe operation, machine shall have a fully enclosed body and an automatic safety release clutch or relief valve.

3.4 APPLICATION

A. Provide appropriate screening to stop passing of materials into downstream sewers. Sludge, dirt, sand, rocks, grease, and other solid or semisolid residue, debris, and material resulting from cleaning operations shall be removed at downstream manhole of section of sewer being cleaned. Passing material from manhole section to manhole section which could cause line stoppages, accumulations of sand in wet wells, or damage to pumping equipment shall not be permitted.

B. Remove debris, residue, and other materials resulting from cleaning operations from site at end of each workday and shall be disposed of in an approved and lawful manner. Under no circumstances will accumulation of debris, residue, and other matter be permitted on site beyond stated time, unless prior written authorization is given for storage in totally enclosed containers.

C. Cleaning per definitions in Part 1 UNIT PRICES

D. Flushing of sanitary sewers to facilitate cleaning activities without the capture of solids and debris is expressly prohibited.

E. Retrieval of equipment lodged in pipes or a wet well is Contractor’s responsibility and shall be performed at Contractor’s expense.

F. Cleaning Precautions: During sewer cleaning operations, satisfactory precautions shall be taken in use of cleaning equipment. When hydraulically propelled cleaning tools (which depend upon water pressure to provide their cleaning force) or tools which retard flow in sewer line are used, precautions shall be taken to ensure that water pressure created does not damage or cause flooding of public or private property being served by sewer. When possible, flow of sewage in sewer shall

be utilized to provide necessary pressure for hydraulic cleaning devices. When additional water from fire hydrants is necessary to avoid delay in normal work procedures, water shall be conserved and not used unnecessarily.

G. No sewer cleaning shall take place in a particular sewer segment until upstream pipe segments have been cleaned. If cleaning is done in a downstream pipe segment in order to facilitate overall cleaning operations, segment shall be re-cleaned at no additional cost to Owner, after pipes upstream of that segment have been cleaned.

H. Sewer line walls shall be cleaned adequately to provide for proper operation of joint testing and sealing equipment or internal inspection to discern structural defects, misalignment and infiltration/inflow sources. Cleaning shall be performed immediately prior to joint testing and sealing and internal inspection to preclude build-up of debris from infiltration/inflow sources and discharges from upstream pipeline sections.

I. Designated sewer manhole sections shall be cleaned using hydraulically propelled, high velocity jet, or mechanically powered equipment. If cleaning of an entire section cannot be successfully performed from one manhole, equipment shall be set up on other manhole and cleaning again attempted. If, again, successful cleaning cannot be performed or equipment fails to traverse entire manhole section, it will be assumed that a major blockage exists and cleaning effort shall be repeated with other types of equipment. Immediately report any blockages to Engineer.

J. Water for sewer cleaning shall be purchased and obtained at locations in accordance with utility owner. If water is obtained from a potable supply, provide appropriate backflow prevention devices as required by authority having jurisdiction to protect potable system from cross connections and contamination. Prevent cross contamination of any public or private water systems used for this purpose.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements, specifies requirements for inspecting and testing.

B. Acceptance of sewer line cleaning is contingent on satisfactory completion of television inspection. If television inspection shows cleaning to be unsatisfactory, re-clean sewer line and re-inspect until cleaning is shown to be satisfactory.

C. If internal joint testing and sealing is to follow cleaning, give particular attention to adequacy of cleaning to ensure that proper seating of sealing packer can be achieved.

D. Inspection of cleaning operations will be made on a daily basis by the Engineer.

3.6 FINAL CLEANING

A. Section 017700 - Closeout Procedures specifies requirements for cleaning.

B. Upon cleaning of underground sewer lines or structures, removal debris from finish grade and clean work areas so conditions at conclusion of the work are equal to or better than areas prior to work of this Section.

END OF SECTION 330130.41

SECTION 330513 - MANHOLES AND STRUCTURES

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. Sanitary manholes and dog house sampling manhole as shown on the drawings
2. Monolithic concrete manholes and structures with masonry transition to cover frame, covers, anchorage, and accessories.
3. Modular precast concrete manhole and structures with tongue-and-groove joints covers, anchorage, and accessories.
4. Bedding and cover materials.

B. Related Requirements:
1. Section 031000 “Concrete Forming and Accessories” for erecting forms and bracing them against movement.
2. Section 032000 “Concrete Reinforcing” for installation of reinforcing steel.
3. Section 033000 “Cast-in-Place Concrete” for concrete type for manhole and structures base pad construction.
4. Section 040514 “Masonry Mortaring and Grouting” for execution requirements for mortar and grout as specified in this Section.
5. Section 042000 “Unit Masonry” for product requirements for clay brick units for use in manhole and structure construction.
6. Section 310515 “Soils and Aggregates for Earthwork” for soil and aggregate for backfill in trenches.
7. Section 315000 “Excavation Support and Protection”

1.3 ACTION SUBMITTALS

A. Section 013300 “Submittal Procedures” for submittals requirements.

B. Product Data: Submit cover and frame construction, features, configuration, dimensions.

C. Shop Drawings: Indicate manhole locations, elevations, piping, sizes and elevations of penetrations.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Products meet or exceed applicable ASTM Standards.

B. Manufacturer Instructions: Detailed instructions on installation requirements, including storage and handling procedures.

C. Field Quality-Control Submittals: Concrete design mix data and concrete test cylinder reports from an approved concrete testing laboratory certifying that the concrete used in the cast-in-place and precast structures conforms with the strength requirements.

D. Qualifications Statements: Qualifications for manufacturer.

1.5 QUALITY ASSURANCE

A. The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer, or other representative of the Owner. Such inspection may be made at the place of manufacture, or on the work after delivery, or at both places and the materials shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein; even though samples may have been accepted as satisfactory at the place of manufacture. Material rejected after delivery to the job shall be marked for identification and shall be removed from the job at once. All materials which have been damaged after delivery will be rejected, and if already installed, shall be acceptably repaired, if permitted, or removed and replaced, entirely at the Contractor's expense.

B. At the time of inspection, the materials will be carefully examined for compliance with the ASTM standard specified below and this Section and with the approved manufacturer's drawings. All manhole sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

C. Imperfections in manhole sections may be repaired, subject to the approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at 7 days and 5,000 psi at 28 days, when tested in 3-in by 6-in cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Engineer.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 “Product Requirements” for transporting, handling, storing, and protecting products requirements.

B. Unload, store, and handle precast manholes according to manufacturer instructions.

C. Storage: Store precast concrete manholes as to prevent damage to Owner's property or other public or private property.

1. Repair property damaged from materials storage.

1.8 AMBIENT CONDITIONS

A. Section 015000 “Temporary Facilities and Controls” for ambient condition control facilities for product storage and installation requirements.

B. Cold Weather Requirements: According to ACI 530/530.1.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318 (318M).

B. Design of Lifting Devices for Precast Components: According to ASTM C913.

C. Design of Joints for Precast Components:
1. According to ASTM C913.
2. Maximum Leakage: 0.025 gal. per hour per foot (0.3 m) of joint at 3 feet of head.

D. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; sleeved to receive pipe sections.

E. Shape: Cylindrical.

F. Clear Inside Dimensions: As indicated on Drawings.

G. Design Depth: As indicated on Drawings.

H. Clear Cover Opening: 26 inches diameter or as indicated on Drawings.

I. Pipe Entry: Furnish openings as indicated on Drawings.

2.2 MANHOLES AND STRUCTURES

A. Manufacturers:
1. Substitutions: Section 016000 “Product Requirements.”

B. Manhole Sections: Reinforced precast concrete according to ASTM C478
1. Gaskets: According to ASTM C923.
2. Manhole Joint: According to ASTM C443
3. The wall thickness shall not be less than 5-in for 48-in diameter reinforced barrel sections, 6-in for 60-in diameter reinforced barrel sections and 7-in for 72-in diameter reinforced barrel sections.

4. Top sections shall be eccentric except that barrel sections shall be used where shallow pipe cover requires a top section less than 4-ft as shown on the Drawings.
5. Barrel sections shall have tongue and groove joints.
6. All sections shall be cured by an approved method and shall not be shipped nor subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 5 days after fabrication and/or repair, whichever is longer.
7. Precast concrete barrel sections with precast top slabs and precast concrete transition sections shall be designed for a minimum of H-20 300 psf loading plus the weight of the soil above at 120 pcf.
8. The date of manufacture and the name and trademark of the manufacturer shall be clearly marked on the inside of each precast section.
9. Precast concrete bases shall be constructed and installed as shown on the Drawings. The thickness of the bottom slab of the precast bases shall not be less than the manhole barrel sections or top slab whichever is greater.

C. Jointing Precast Manhole Sections
1. Tongue and groove joints of precast manhole [and structure] sections shall be sealed with either a round rubber O-ring gasket or a preformed flexible joint sealant. The O-ring shall conform to ASTM C443. The preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent; Ram-Nek by K.T. Snyder Company or equal.

2. Joints shall be designed and manufactured so that the completed joint will withstand an internal water pressure of 15 psi without leakage or displacement of the gasket or sealant.

2.3 FRAMES AND COVERS

A. Manufacturers:
1. Substitutions: Section 016000 “Product Requirements.”
2. Construction: ASTM A48 (A48M), Class 30B cast iron.
3. Surface: Machined flat bearing.
4. Lid: Removable and boltable.
5. Cover Design: Closed.
6. Sealing gasket.
7. Cover: Molded with City of Flint name and logo.

2.4 MATERIALS

2.5 FINISHES

A. Steel Galvanizing: ASTM A123. Hot dip galvanize after fabrication.

2.6 ACCESSORIES

A. Manhole Steps:
1. Manhole rungs shall be steel reinforced copolymer polypropylene plastic. Rungs shall be 14-in wide, M.A. Industries Type PS2-PF-SL or equal. Copolymer polypropylene shall conform

to ASTM D4101, PP0344 B33534 Z02. Steel reinforcing shall be 1/2-in diameter, grade 60 conforming to ASTM A615 and shall be continuous throughout the rung. The portion of the legs to be embedded in the precast section shall have fins and be tapered to insure a secure bond.

B. Base Pad: Leveled top surface. Cast-in-place concrete of type as specified in Section 033000 "Cast-in-Place Concrete."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 "Execution" for installation examination requirements.

B. Verify that items provided by other Sections of Work are properly sized and located.

C. Verify that built-in items are in proper location and ready for roughing into Work.

D. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Section 017300 "Execution" for installation preparation requirements.

B. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as indicated on Drawings to indicate its intended use.

C. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

D. Do not install structures where Site conditions induce loads exceeding structural capacity of structures.

E. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage; remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:
   1. Manhole shall be constructed to the dimensions shown on the Drawings and as specified herein. All work shall be protected against flooding and flotation.
   2. Provide clearance around sidewalls of structure for construction operations.
   3. When groundwater is encountered, prevent accumulation of water in excavations; place manholes in dry trench.
   4. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation as approved by Engineer.

B. Base Pad:
   1. The bases of manholes shall be placed on a bed of 12-in screened gravel. The bases shall be set at a grade to assure that a maximum of 8-in thickness of brickwork will bring the manhole frame and cover to final grade. Cast-in-place bases shall be constructed in accordance with the requirements of Division 3 and the details shown on the Drawings.

C. Place manhole and structure sections plumb and level, trim to correct elevations, and anchor to base pad.

D. Backfilling shall be done in a careful manner, with granular material bringing the fill up evenly on all sides.

E. Form and place manhole cylinder plumb and level and to correct dimensions and elevations.

F. Cut and fit for pipe.

G. Grout base of shaft sections to achieve slope to exit piping, trowel smooth, and contour as indicated on Drawings.

H. Set cover frames and covers level without tipping and to correct elevations.

I. Coordinate with other Sections of Work to provide correct size, shape, and location.

J. Masonry Manholes:
   1. Maintain masonry courses to uniform dimension.
   2. Form vertical and horizontal joints of uniform thickness.
   3. Lay masonry units in running bond.
   4. Course one unit and one mortar joint to equal 8 inch.
   5. Form flush mortar joints.
   6. Lay masonry units in full bed of mortar, with full head joints, uniformly jointed with other Work.
   7. Install joint reinforcement 16 inch o.c.
   8. Place joint reinforcement in first and second horizontal joints above base pad and below cover frame opening.

K. Precast Concrete Manholes:
   1. Lift precast components at lifting points designated by manufacturer.
   2. When lowering manholes into excavations and joining pipe to units, take precautions to ensure that interior of pipeline and structure remains clean.
   3. Set precast structures bearing firmly and fully on crushed stone bedding, compacted as specified or on other support system as indicated on Drawings.
   4. Assemble multi-section structures by lowering each section into excavation; set level and firmly position base section before placing additional sections.
   5. Remove foreign materials from joint surfaces and verify sealing materials are placed properly.
   6. Maintain alignment between sections by using guide devices affixed to lower section.
   7. Joint sealing materials may be installed on Site or at manufacturer's plant.
   8. Verify that installed manholes meet required alignment and grade.

9. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe; fill annular spaces with mortar.
10. Cut pipe flush with interior of structure.
11. Shape inverts through manhole as indicated on Drawings.

3.4 FIELD QUALITY CONTROL

A. Section 014000 “Quality Requirements” for inspecting and testing requirements Section 017300 “Execution” for testing, adjusting, and balancing requirements**.**

B. Test concrete manhole and structure sections according to ASTM C497.

C. Test cast-in-place concrete as specified in Section 033000 “Cast-in-Place Concrete.”

D. Vertical Adjustment of Existing Manholes and Structures:
1. If required, adjust top elevation of existing manholes and structures to finished grades as indicated on Drawings.
2. Reset existing frames, grates, and covers that were carefully removed and cleaned of mortar fragments to required elevation according to requirements specified for installation of castings.
3. When removal of existing concrete wall is required, remove concrete without damaging existing vertical reinforcing bars, clean concrete from vertical bars, and bend into new concrete top slab or splice to required vertical reinforcement as indicated on Drawings.
4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete as specified in Section 033000 “Cast-in-Place Concrete.”

E. Leakage Tests:
1. Performed on every manhole with Engineer observing.
2. Preparation:
   a. Prior to placing the shelf and invert, and pointing the horizontal joints, fill all lifting holes within 6 feet of ground surface with approved non-shrinking mortar.
   b. Lower groundwater table as required.
   c. Plug all pipes and other openings into manhole.
3. Test:
   a. Fill water to top of cone section.
   b. Observe for visible water in the excavated area.
   c. If area around manhole is backfilled or the test is unsatisfactory, repeat the test allowing for suitable time for absorption of water in the excavated area.
   d. At the end of the absorption period, refill manhole and wait 8 hours.
   e. Refill the cone at the end of 8 hours, measuring the amount required to refill.
   f. Extrapolate to determine 24-rate of leakage. Leakage not exceed 1 gallon per vertical foot in a 24-hour period.
   g. Engineer will perform visual inspection along with the Contractor.
4. Repair:
   a. If leakage is less than 3 gallons per vertical foot per 24 hours, make approved repairs to the manhole and retest, if it is determined the leakage is due to defects in the joints or sections.
   b. If leakage is 3 gallons or more, then replace the entire manhole, including all joints and sections at the Contractor’s expense. Retest the new manhole as described above.

F. A vacuum test may be substituted for a leakage test as follows:
   1. The filling and pointing of exterior joints are not required where the excavation has not been backfilled.
   2. Inflate to affect a seal between the vacuum base and the top of the manhole.
   3. Connect the vacuum pump to the outlet port with the valve open and a vacuum of 10" Hg (20" of Hg absolute) drawn.
   4. Close the valve.
   5. The following test criteria shall apply to 4-ft and 5-ft diameter manholes:
   6. Allowable drops in pressure:
      a. Manholes 0 – 10 ft. deep:
         1) drop of 1" Hg over 2 minutes.
      b. Manholes 10 -15 ft. deep:
         1) Drop of 1” Hg over 2-1/2 minutes
      c. Manholes 15 - 30 feet:
         1) Drop of 1” Hg over 3 minutes
   7. If the pressure drop exceeds the acceptable limits, make necessary repairs as approved by the Engineer, and:
      a. Re-test the manhole.
      b. If the manhole fails to meet the minimum requirements of the vacuum test retest using the leakage test.
   8. Upon completion of a successful vacuum test, the interior and exterior joints shall be filled and pointed.

3.5 CLEANING

A. Clean all new manholes to be free of silt, debris and foreign matter of any kind, prior to final inspection.

3.6 ATTACHMENTS

A. Storm Sewer Manholes: Precast concrete sections, galvanized steel steps, not less than 48 inches inside dimension, to depth indicated, with bolted lid.

B. Electric Service Manholes: Prefabricated FRP sections, integral molded steps, 60 inches inside dimension, to depth indicated.

END OF SECTION 330513

SECTION 330519 - DUCTILE-IRON UTILITY PIPE FOR WATER SERVICE

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. Materials, equipment and incidentals required to install and test ductile iron pipe and fittings for yard piping as shown on Drawings and as specified.
      a. The word "pipe" is used to refer to pipe, fittings, or appurtenances unless otherwise noted.
   2. Yard Piping: Includes piping and fittings extending outward, upward and downward into the ground from the outside face of all buildings. Unless otherwise noted, non-buried pipe outside a building, including in utility tunnels, shall be specified in Division [40].

   3. Locate piping as shown on the Drawings. The Engineer reserves the right to make modifications in locations as may be found desirable to avoid interference between pipes or for other reasons.

B. Related Requirements:
   1. Section 310515, “Soils and Aggregates for Earthwork” for granular fill
   2. Section 312323.33, “Flowable Fill
   3. Section 312333, “Trenching and Backfilling
   4. Section 312500, “Erosion and Sedimentation Controls
   5. Section 321216, “Asphalt Paving

1.3 COORDINATION

A. Section 013100 “Project Management and Coordination” specifies requirements for coordination.

1.4 PREINSTALLATION MEETINGS

A. Section 013100
Project Management and Coordination” specifies requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.5 ACTION SUBMITTALS

A. Section 013300, “Submittal Procedures” for submittals requirements.

B. Shop Drawings and Product Data:
   1. Including piping layouts, design calculations, warranty information, test reports, in accordance with Section 013300 and the referenced standards.
   2. Design calculations in accordance with the “Pipe Wall Thickness Analysis” Paragraph under Part 2 Products, below, signed by a Professional Engineer, as noted in Section 013300.
   3. Name of the pipe and fitting suppliers and a list of materials to be furnished.
   4. Warranties per Section 017836.
   5. Anticipated production and delivery schedule.

1.6 DELEGATED DESIGN SUBMITTALS

A. Tabulated Laying Schedule:
   1. Reference stations and invert elevations as shown on the Drawings
      a. Include fittings, bends, outlets, restrained joints, tees, special deflection bells, adapters, solid sleeves and specials.
   2. Manufacturer's drawings and specifications providing complete details of all items. Show on the laying schedule:
      a. Pipe class,
      b. Class coding,
      c. Station limits
      d. Transition stations
      e. Various pipe classes
      f. Submit to engineer for approval before manufacture and shipment.
   3. Full length pipe may be supplied from inventory provided that all specification requirements are met. Shop drawings shall include but not be limited to:
      a. Complete and dimensional working drawings of pipe layouts, including pipe stationing, invert elevation at changes in grade or horizontal alignment, all elements of curves and bends both in horizontal alignment and vertical position.
   4. The grade of material; size, wall thickness, of the pipe and fittings and appurtenances, type and location of fittings, specials, and valves; and the type and limits of the lining, lining reinforcing and coating systems of the pipe and fittings. Methods and procedures recommended by the coating manufacturer to also be documented.
   5. Joint details; methods and locations of supports and complete information concerning type, size and location of all welds.
      a. Shop welds (no field welding will be allowed) will be clearly differentiated
      b. welds will be clearly detailed with preparation procedures for all pipe and parent material comprising each weld.
      c. Critical welding procedures will be identified along with methods for controlling welding stresses and distortions.
      d. Locations and proposed joint details will also be clearly identified.
   6. Method of manufacture of pipe; joint details, fittings and any specials.
   7. All other pertinent information for all items to be furnished; product data to show compliance of all couplings, supports, fittings, coatings and related items.

1.7 INFORMATIONAL SUBMITTALS

A. Prior to Pipe Shipment:
   1. Certified copies of mill tests confirming the type of materials used in the pipe, and shop testing of pipe to show compliance with the requirements of the applicable standards, along with a sworn affidavit of compliance that the pipe complies with the referenced standards.
   2. Certified affidavit of compliance from manufacturer stating that pipe, fittings, gaskets, linings and exterior coatings for project have been manufactured and tested in accordance with AWWA and ASTM standards and requirements specified herein.

B. Copies of shop tests, including hydrostatic tests.
   1. Qualifications for manufacturer, fabricator, applicator, installer, erector, and licensed professional.
   2. Manufacturer's approval of applicator fabricator installer.

1.8 QUALITY ASSURANCE

A. Perform Work according to standards set by authorities having jurisdiction.

B. Designed and supplied by a single manufacturer. Pipe and Fitting Connections: Pipe to be supplied by a single manufacturer and fittings may be supplied by a different manufacturer**.**

C. Inspection of Pipe and Fittings After Delivery: By Engineer or representative of the Owner.
   1. Pipe and fittings subject to rejection if failing to meet specified requirements even though pipe may have been accepted as satisfactory at the place of manufacture.
   2. Pipe rejected after delivery (including defects from manufacturing or delivery/transport) to be marked for identification and immediately removed from the job.

D. Pipe and fittings marked in accordance with all applicable AWWA standards. Legibly and permanently mark pipe, fittings, specials and appurtenances to be consistent with the laying schedule and marking drawings (if required) with the following information:
   1. Manufacturer
   2. Date of manufacture.
   3. Size, type, class, or wall thickness.
   4. AWWA Standard(s) produced to.
   5. Pipe identified with sequential numbering consistent with the laying schedule and marking drawings and each marked pipe will appear on the marking drawings in the identified location for installation.
   6. Special fittings, bends, and appurtenances requiring specific orientation will be appropriately marked with the words "TOP" in the correct position and in a consistent location.

1.9 QUALIFICATIONS

A. The manufacturer shall meet the following criteria and furnish the necessary project information, which demonstrates the required experience:

1. Experience that includes successful fabrication (followed by installation, acceptance and service) to AWWA C151 standards of at least 10,000 lineal feet of the largest specified diameter or larger ductile iron pipe with similar linings/coatings within the past 5 years.
2. Experience to include the successful fabrication of at least 50 fittings in compliance with AWWA C110 or C153 of the largest specified diameter or larger with similar lining/coatings within the past 5 years.
3. Experience that includes the successful fabrication (followed by installation, acceptance and service) of at least 10,000 lineal feet of the largest specified diameter or larger push-on style, boltless restrained joint for ductile iron pipe within the last 5 years.

B. Pipe Origin: Manufactured in the United States. Ductile iron pipe to be supplied by a single manufacturer.

C. Fittings Origin: Manufactured in or outside the United States but supplied by one of the named pipe fitting manufacturers in Part 2 or Engineer approved equal. Ductile iron fittings to be supplied by a single manufacturer. Written certification fittings are compatible with the supplied brand of pipe.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000, “Product Requirements” for transporting, handling, storing, and protecting products requirements.

B. Delivery: Per AWWA C600 and referenced AWWA Standards for shipping, handling and storage procedures.
1. Deliver materials in manufacturer's packaging including application instructions.
2. Handle to prevent injury to the pipe, pipe linings and pipe coatings.
    a. Examine pipe and fittings as noted in Division 1. Damage to linings or coatings discovered during examination to be repaired to the satisfaction of the Engineer before proceeding with the work.
3. Transport pipe to job site on padded bunks or oak timbers and secured with steel banding or nylon tie down straps adequately protecting the pipe and coating.
    a. Handle pipe using slings, hooks, pipe tongs or other devices acceptable to the Engineer.
    b. Do not use non-cushioned ropes, chairs, wedges, cables or levers when handling finished pipe, fittings or couplings.
    c. Do not drop pipe or fittings.
    d. Do not skid pipe or fittings against each other.
    e. Do not mar pipe or fitting coatings.
    f. Utilize padded wooden pipe cradles or chocks suitable for protecting coatings between and beneath finished pipes when pipes are placed upon rough surfaces.

C. Storage:
1. Do not store pipe on bare ground unless soft sand berms are used to support the pipe and is approved by the Engineer.
2. Keep materials safe from damage if stored. The interior of pipe, fittings and other appurtenances to be kept free from dirt, excessive corrosion or foreign matter.

3. Do not stack pipe higher than the limits recommended by manufacturer. Keep the bottom tier off the ground using timbers, rails, or concrete. Stacking to conform to manufacturer's recommendations and/or AWWA C600.
4. Sore gaskets for mechanical and push-on joints in a cool location out of direct sunlight; not in contact with petroleum products. Use gaskets on a first-in, first-out basis.

D. Protection:
1. Lined and coated pipe: Suitably protected from exposure and heating from the sun. Follow procedures recommended by the coating and lining system manufacturer.
   a. Exposure will not be allowed except for short periods such as installation, assembly and repairs.
2. Metal tools or heavy objects are not permitted to come in contact unnecessarily with the finished coating.
   a. Workers may walk on coated pipe only when necessary, and only when wearing footwear with rubber or composition soles and heels sufficiently free of dirt and mud so coating remains undamaged.
3. Prevent damage to linings and coatings caused by handling, onsite storage, and exposure to low temperatures (due to embrittlement), high temperatures, or direct sunlight.

1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field locations and sizes of connections to existing piping and equipment prior to submitting pipe lay drawings.
1. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Section 017700 “Closeout Procedures” for warranties requirements.

B. Furnish two year manufacturer's warranty for ductile iron pipe and fittings.

PART 2 - PRODUCTS

2.1 SYSTEMS

A. Assure compatibility between joints of all items supplied.

2.2 DUCTILE IRON PIPE

A. Manufacturers: Provide pipe and fittings supplied by:
1. American Cast Iron Pipe Co.
2. U.S. Pipe and Foundry.
3. Griffin Pipe Products.
4. McWane Company; all pipe divisions.

5. An approved equivalent member of the Ductile Iron Pipe Research Association (DIPRA).

B. Fitting Certification: From fitting manufacturer; written certification that fittings are compatible with supplied brand of pipe.

C. Ductile Iron Pipe: Per AWWA C151 and ANSI A21.51. Provide in standard lengths as much as possible.

D. Thickness Design: Per AWWA C150**:**
1. Piping 12 inches and Smaller: Minimum Class 350.

E. Gravity Sewer Piping: Per ASTM A746.

F. Culvert Piping: Per ASTM A716.

G. Pipe Wall Thickness Analysis:
1. Tensile strength: 60,000 psi
2. Yield strength of 42,000 psi (per AWWA M-41).
3. Design and analyze external and internal pressures separately. Use the larger of the two to determine the net design thickness.
4. Design additional allowances for service allowance and casting tolerance per AWWA C150.
5. Pipe Classes: The minimum pipe class specified in the Thickness design paragraph above.
6. Design the net thickness for external loading based on the greater of the following conditions:
   a. Cover: 30 inches with HS-20 wheel loads per AASHTO Standard Specifications for Highway Bridges, with an impact factor of 1.5.
   b. Depth from existing ground level or future proposed grade, whichever is greater, to top of pipe as shown on the Drawings, with truck load.
   c. Soil Density: 125 lbs per cu ft.
   d. Laying Conditions: Per AWWA C150, Type [**2**].
7. Design the net thickness based upon the following internal pressure conditions:
   a. Design Pressure: 150 psi.
   b. Surge Allowance: 100 psi.
   c. Safety Factor: 2.
   d. Total Internal Pressure Design: 250 psi.
   e. E': 300 psi.
8. Furnish to the Engineer for approval, copies of design calculations showing pipe meets the specified requirements during shop drawing review in accordance with Section 013300.

2.3 END TREATMENTS/JOINTS

1. Unrestrained Pipe and Fitting Joints: Push-on rubber gasket type or rubber-gasket mechanical joint per AWWA C111, except where flanged joints are required as shown on the drawings.
2. Restrained Pipe and Fitting Joints: Push-on rubber gasket, locking ring type joints per the manufacturer' standard described below, except where flange joints are shown on the Drawings.
3. Gasket materials: Per Table 5-1 of AWWA M-41.
   a. Rubber-Gasket Joints: Per AWWA C111. Styrene butadiene rubber (SBR).

4. Restraints for push-on joint pipe and fittings to be positive locking, utilizing restraints independent of the joint gasket.
    a. Joint Test Pressure 250 psig
    b. Joint Fabrication: Heavy section ductile iron casting.
    c. Bolts and Nuts: Low carbon steel conforming to ASTM A193, Grade B7.
    d. Restraint for mechanical joint pipe shall use retainer glands for restraining joint.
5. Provide restrained push on joints from one of the following manufacturers or an Engineer approved equivalent.
    a. US Pipe and Foundry Company: "TR Flex."
    b. American Cast Iron Pipe Company: "Lok-Ring" or "Flex Ring (positive locking style)."
    c. Griffin Pipe Products Company: "Snap Lok."
    d. Clow Water Systems Company: "Superlok."
6. Determine the minimum number of restrained joints required for resisting forces at fittings and changes in direction of the pipe from the length of restrained pipe on each side of the fittings and changes in direction necessary to develop adequate resistance friction with the soil.
    a. The required lengths of restrained joints shall be as shown on the Drawings.
7. Restrained pipe joints incorporating cut out sections in the pipe wall must have a minimum wall thickness at the cut out corresponding with the minimum specified wall thickness for the rest of the pipe.
8. Pipe manufacturer proprietary mechanical joint restraint systems that utilize a wedge-style gripping system or a gland/ring positive restraint system will be considered acceptable on a case by case basis as determined by the Engineer.
    a. The optional mechanical joint restraint shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron per ASTM A536. Dimensions of the gland must be such that it can be used with the standard mechanical joint bell and tee-headed bolts, as specified with the pipe.
    b. Restraint Mechanism:
        1) Individually activated gripping surfaces maximizing restraint capability.
        2) Wedges designed to spread the bearing surfaces on the pipe.
        3) Torque limiting twist-off nuts sized same as T bolts for mechanical joints. When the nut is sheared off, standard hex nut shall remain.
    c. Restraint Device for Ductile Iron Pipe: EBAA Iron Megalug Series 1100, or approved equivalent.
        1) Working Pressure: 250 psi and a safety factor of 2:1.
9. Threaded Ductile Iron Flanges
    a. Fabricated per AWWA C115 and sealed during installation with a special high pressure, full face gasket per AWWA C111.
    b. At pipe manufacturer's option, the use of 250 lbs pattern flanges, faced and drilled in accordance with ANSI B16.1 may be substituted in order to match valves or other equipment or to meet the required working pressure requirements.
    c. Flanges:
        1) Rated for the same pressure as the adjacent pipe in all cases.
        2) Compatible with 250 lbs class and higher special class AWWA valves.
        3) Pre-drilled and faced after being screwed onto the pipe,
        4) True to 90 degrees of the pipe axis and shall be flush with the end of the pipe.
    d. Gaskets: Full face rubber, 1/8 inch thick SBR material.

1) American Torseal Gasket or approved equal.
2) Special material ring gaskets such as those by Garlock or equivalent may be required if pressures exceed 250 psi for ANSI rated and custom flanges.

e. Flanged joints:
1) Supplied with bolts and nuts on one end.
2) Bolt studs with a nut at each end, or studs with nuts on one end where the flange is tapped.
3) Quantity and size of bolts to comply with the corresponding flange standard.
4) Bolts and Nuts: Per ASTM A193, grade B7.

f. Blind flanges shall mate with regular flanges.

g. Filler flanges and beveled flange fillers shall be furnished faced and drilled complete with extra length bolts.

10. Couplings and Adapters Sleeve Type Couplings: Dresser Style 38, 138 or equivalent by:
a. Ford Meter Box Co.
b. Smith Blair
c. Romac Industries.

11. Buried Sleeve-Type Couplings: Protective wrapping of "Denso" material by DENSO Inc. of Texas or equivalent.
a. Where "Denso" material is used, pack joint with "Densyl mastic" to give an even contour for wrapping with "Densopol" tape.
b. Apply a 1/16 inch thick coating of "Denso" paste followed by 4 inch or more wide "Densopol" tape wound spirally around the joint with at least 50 percent overlap.

2.4 FITTINGS

1. Pipe Fittings: Ductile iron per AWWA C110 or AWWA C153 as applicable. Fittings to have the same pressure rating, as a minimum, of the connecting pipe.
a. Piping 24 inch and smaller: minimum pressure rating of 350 psi

2. Closures: Made with mechanical joint ductile iron solid sleeves. Locate in straight runs of pipe at minimum cover outside the limits of restrained joint sections; subject to approval of the Engineer.

3. Weld-on Outlets: May be used as an alternative to ductile iron cast fittings. Limited to branch outlets having a nominal diameter not greater than 30 percent of the nominal diameter of the main pipe, or 14 inches diameter, whichever is smaller.
a. May be provided as radial tee outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main pipe (in 1 degree increments between 45 and 90 degrees from the axis of the main pipe).
b. Welded onto the pipe under the supervision of a qualified welder at the same facility where the pipe is manufactured. Pipe manufacturer to have 5 years' experience in the fabrication and testing of outlets of similar size and configuration. Field welding of outlets is not acceptable.
c. Joints to be compatible with connecting pipe and meet where applicable, requirements of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15.
d. Welding Procedures: As determined by the pipe manufacturer.
1) Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron pipe.
a) Designed per ANSI/AWWA C150/A21.50
b) Manufactured per ANSI/AWWA C151/A21.51.
c) Minimum class for sizes 4 through 54 inch; special thickness class 53.

e. Rated for the working pressure indicated on the Drawings and the connecting pipe.
f. Prior to application of coating or lining in the outlet area, weldments for branch outlets supplied for this project will be subjected to an air pressure test of 1 15 psi. Air leakage is not acceptable a hydrostatic test of 500 psi. No leakage is allowed on the hydrostatic test. The hydrostatic test shall be done prior to cutting out the parent pipe. The rating, safety factor and testing must be certified and contained in the manufacturer's submittal package.

2.5 LININGS, COATINGS & CORROSION PROTECTION

A. Interior Lining:
1. Ductile iron pipe and fittings shall have the same type of lining.
2. Cement Mortar Lining: Per AWWA C104. Cement type per ASTM C150.
a. At Supplier’s Option: Fittings may be lined per AWWA C550; NSF/ANSI 61 certified.

B. EXTERIOR COATING
1. Buried pipe installed with bituminous coating per AWWA C151 and C110 respectively.
2. Install buried pipe with polyethylene encasement.
a. Polyethylene Encasement: 8 mils thickness meeting standards per AWWA C105.
1) Three layers of co-extruded linear low-density polyethylene (LLDPE), fused into a single thickness not less than eight mils. Infuse the inside surface in contact with the pipe exterior with an antimicrobial compound and volatile corrosion inhibitor blend, mitigating microbiologically influenced corrosion galvanic corrosion.
2) Polyethylene encasement shall be V-Bio, as patented by DIPRA.
b. Manufacturers:
1) North Town Company
2) AA Thread and Seal Tape, Inc.
3) Sigma Corp.
4)
c. Size Requirements: Per TABLE 3, section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
d. Test Results: Submitted to Engineer for approval prior to use.
1) Testing: Independent testing agency certifying polyethylene encasement meets criteria established by AWWA C105 associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.
2) Samples: Include with test results.
e. Plastic Adhesive Tape: 2 inch for sealing seams, cuts, or tears in polyethylene encasement. Duct tape is not acceptable.
1) Calpico Vinyl
2) Polyken
3) U.P.C.

2.6 SOURCE QUALITY CONTROL

A. Section 014000, “Quality Requirements” for testing, inspection, and analysis requirements.

B. Certificate of Compliance: When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

2.7 Specified shop tests are not required for Work performed by approved fabricator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution” for installation examination requirements.

3.2 PREPARATION

A. Section 017300 “Execution” for installation preparation requirements.

B. Handle piping and fittings per “Delivery, Storage, and Handling” Article in Part 1 of this specification.

C. Examine pipe and fittings before laying. Repair any damage to the pipe, lining or coatings per manufacturer's recommendations prior to installation.

D. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter at all times.

3.3 INSTALLATION

A. Installed per requirements of the laying schedule and AWWA C600, unless otherwise specified.
   1. Provide firm, even bearing the length of the pipe. Dig bell holes at each joint. Tamp backfill materials on pipe sides to the springline per details on the Drawings.
   2. Blocking is not permitted.
   3. Replace with sound pipe or fitting, defective pipe or fitting discovered after having been laid.
   4. When laid, pipe and fittings shall perform to lines and grades required. When laying is not in progress, close open ends of the pipe with watertight plug or other approved means.
   5. Place sufficient backfill to prevent flotation. Joint deflection not to exceed manufacturer’s recommendation.
   6. Pipe Laid Underground: 3 feet cover unless Drawings show otherwise or otherwise specified.
   7. Lay pipe such that the invert elevations shown on Drawings are not exceeded.

8. Provide fittings, in addition to those shown on the Drawings, where required, in crossing utilities which may be encountered upon opening the trench. Install solid sleeve closures at locations approved by the Engineer.
9. Pipe Interior: Maintain dry and broom clean throughout construction period.
10. Field Cutting Pipe: When required, smooth cut by machine perpendicular to pipe axis. Bevel cut pipe ends per manufacturer's recommendations for the spigot end.
    a. Repair coating removed from cut per manufacturer's recommendation and/or the coating and lining paragraphs of Part 2 above (whichever method is more stringent in the opinion of the Engineer).
    b. Cement lining shall be undamaged.
    c. Cutting of restrained joint pipe will not be allowed, unless approved at specific joints in conjunction with the use of restrainer glands by EBAA Iron or field adaptable restrained joints.
    d. Where Field Cuts are Permitted" Pipe supplied by the factory as "gauged full length".
        1) Gauged Full Length Pipe is Unavailable: Pipe to be field gauged at the location of the new spigot using a measuring tape, or other means approved by the manufacturer, to verify that the diameter is within tolerances permitted in Table 1 of AWWA C151.

B. Jointing Ductile-Iron Pipe
1. Push-On Joints: Install per manufacturer's instructions, AWWA C600 and Appendix B of AWWA C111. If there is conflict, manufacturer's instructions take precedence.
    a. Lay pipe with bell ends looking ahead.
    b. Insert rubber gasket in the groove of bell end of pipe.
    c. Clean and lubricate joint surfaces
    d. Align the plain end of the pipe with the bell of the pipe to which it is to be joined and pushed home.
    e. Metal feeler shall be used to make certain that the rubber gasket is properly seated.
2. Mechanical Joints: Assembled per manufacturer's instructions, AWWA C600 and Appendix A of AWWA C111. If there is conflict, manufacturer's instructions take precedence.
    a. Lay pipe with bell ends looking ahead.
    b. Clean and lubricate joint surfaces and rubber gasket.
    c. Tighten bolts to the specified torques.
    d. Extension wrenches or pipe over handle of ordinary ratchet wrench are not allowed to secure greater leverage.
    e. Encapsulate bolts and nuts using wax sealing tape per AWWA Standard C217.
    f. Install polyethylene encasement as specified.
3. Bolts in Mechanical or Restrained Joints: Tightened alternately and evenly.
4. Restraint for Mechanical Joint Pipe:
    a. Retainer glands for restraining joint.
    b. Restrained mechanical joints to be suitable for the specified test pressure.
    c. Installed according to pipe manufacturer's instructions.
5. Flanged Joints: Assembled per manufacturer's instructions and Appendix C of AWWA C111. If there is conflict, manufacturer's instructions take precedence.
    a. Ensure there is no restraint on opposite ends of pipe or fitting, which would prevent uniform gasket compression, cause unnecessary stress, bending or torsional strains, or distortion of flanges or flanged fittings.
    b. Adjoining push-on joints are not to be assembled until flanged joints have been tightened.

c. Tighten flange bolts for uniform gasket compression and sealing.
   1) Leave flange bolts with approximately 1/2 inch projection beyond the nut face after tightening.
d. Encapsulate bolts and nuts using wax sealing tape per AWWA Standard C217,

6. Sleeve Couplings: Only installed for closure or as shown on the Drawings. Do not assemble couplings until adjoining joints have been assembled.
   a. Encapsulate bolts and nuts using wax sealing tape per AWWA Standard C217,
   b. Install protective wrap recommended by manufacturer or as required herein. Maintain insulating properties of insulating and dielectric couplings.
7. Blowoffs, outlets, valves, fittings and other appurtenances to be set and jointed as indicated on the Drawings and per manufacturer's instructions.

C. Polyethylene Encasement
1. Install polyethylene encasement around ductile iron pipe to limits shown on the Drawings and in accordance with pipe manufacturer's recommendations.
   a. Installed per ANSI/ AWWA C105/A21.5, Method 'A' in accordance with section 2.15 of DIPRA's Installation Guide for Ductile Iron Pipe.
2. Use a fabric type or padded sling when handling pipe to prevent damage to the encasement.
3. Seal seams with approved 2 inch wide plastic adhesive tape.
4. Repair encasement rips or tears with tape and film per ANSI/AWWA C105/A21.5.
5. When backfilling does not damage the polyethylene encasement.

D. Cathodic Protection Systems:
1. Joints: Electrically bonded with bonding wire and brazing cartridges per Section <Insert section number>.
2. Factory applied copper conductivity straps may be used in lieu of field applied bonding wire.

3.4 CONNECTIONS TO STRUCTURES

A. Where pipe 3 inch diameter or larger horizontally passes from concrete to earth, install two flexible joints spaced 2 to 4 feet apart depending on pipe size within 2 feet of exterior wall face, whether shown on Drawings or not.

B. Utilize wall sleeves for pipes passing through walls designed to pass through the wall via restrained piping unless otherwise specified.

C. Encase piping underneath structures in reinforced concrete as shown in the Drawings.

3.5 FIELD QUALITY CONTROL

A. Section 014000, “Quality Requirements” for inspecting and testing requirements.

B. Replace with sound pipe or fitting, defective pipe or fitting discovered after having been laid.

C. Thoroughly clean pipe and fittings before laying. Keep clean until used in the Work.

D. Pipe and fittings, when installed or laid, shall conform to the lines and grades required.

E. FILLING AND TESTING
1. After Installation: Test pipe shall for compliance as specified.
   a. Furnish necessary equipment and labor for hydrostatic pressure testing the pipelines.
   b. Submit detailed test procedures and methods per AWWA C600 for Engineer's review and approval at least 10 days prior to testing
2. Pressure Pipelines: Subjected to hydrostatic pressure of **250** psig or 1.25 times the working pressure at the highest point along the test segment.
   a. Maintained test pressure for 2 hours.
   b. Hydrostatic testing allowances are not to exceed those indicated in AWWA C600.
   c. Provide suitable restrained bulkheads as required to complete the specified hydrostatic testing.
   d. Make taps and furnish necessary caps, plugs, etc., required to conduct testing.
3. Gravity Pipelines: Subjected to hydrostatic pressure test as specified in AWWA C600.
4. Valves and Valve Boxes" Properly located, installed and operable prior to testing.
5. Provide bulkheads with a sufficient number of outlets for filling and draining the line and for venting air.
6. Hydrostatic Pressure Tests: Per Section 5.2 of AWWA C600.
   a. Furnish gauges, meters, pressure pumps and other equipment required to slowly fill the line and perform the required tests.
7. Owner will provide a source of supply from the existing treated water distribution system for use in filling the lines. An air break shall be maintained at all times between the distribution system and equipment to prevent cross-connection.
   a. Slowly fill the line with water. Maintain the specified test pressure in the pipe for entire test period. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.
8. Pressure Test Duration: 2 hours.
   a. Repair leaks evident at the surface regardless of total leakage as shown by test.
   b. Repair lines failing to meet tests. Retest as necessary until test requirements are met.
   c. Defective materials, pipes, valves and accessories shall be removed and replaced.

3.6 CLEANING AND DISINFECTION

A. Sections 017300 "Execution" and 017700 "Closeout Procedures" for cleaning requirements.

B. At conclusion of the Work, thoroughly clean pipes by flushing with water or other means to remove dirt, stones, pieces of wood, or other material which may have entered during the construction period. Remove all debris from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

C. After pipes have been cleaned and if groundwater level is above the pipes or water in the pipe trench is above the pipe following a heavy rain, the Engineer will examine the pipe for leaks.
1. Repair and replace defective pipes, fittings or joints that are discovered.

D. Potable Water Service: Disinfect ductile iron pipe used for potable water service after cleaning. Provide necessary equipment and labor.
1. Disinfection per AWWA C651 standard.
2. Discharge chlorinated water in compliance with Federal, State and local standards. Provide sodium bisulfite for de-chlorination prior to discharge.

3.7 PROTECTION

A. Section 017300 “Execution” for protecting finished Work requirements.

3.8 EXHIBIT A

Use as a reference

INTERIOR LININGS AVAILABLE FOR DUCTILE IRON PIPE

Description	Max./ Service (1) Temp. (Degrees F)	Common Uses	Thickness
CEMENT MORTAR (AWWA C104			
With Sealcoat	150 degrees	Salt water	
Without Sealcoat	212 degrees	Drinking Water Non-Septic Gravity Sewers Sanitary sewers Force Mains	Standard per AWWA C104 or double
GLASS		Scum	10 Mil (nominal)
PETROLEUM ASPHALT COATING	150 degrees	Air	1 Mil
PROTECTOR 401 (CERAMIC-FILLED AMINE-CURED EPOXY)	120-150 degrees (2)	Septic sewers Acids (3) Alkali Waste Pickling brine	40 Mil (nominal)
EPOXIES SUITABLE FOR DRINKING WATER (4)	120-150 degrees (2)	Drinking Water Food Processing	24 Mil (minimum)
POLYETHYLENE	120-150 degrees (5)	Septic Sewers Acids (3) Alkali Waste Pickling Brine	40 Mil (nominal)

(1) Maximum service temperatures listed are intended as general guidelines. For higher service temperatures, consult manufacturer for specific recommendations.
(2) Maximum service temperatures for epoxies depends on service conditions and specific formulation. Consult manufacturer for recommendations for elevated temperature service.
(3) Consult manufacturer for specific acid service use.
(4) All epoxies are not suitable for conveying drinking water. Consult manufacturer for recommendations. Many jurisdictions require NSF 61 certifications for linings in contact with drinking water.
(5) Maximum service temperature for polyethylene for acids and alkali waste depends on the specific acid or alkali waste and service condition(s). consult manufacturer for recommendations for elevated temperature service.

3.9 EXHIBIT B

EXHIBIT B

Use as a Reference

GASKET MATERIALS USED FOR DUCTILE IRON PIPE IN WATER AND SEWERAGE SERVICE

Description	Maximum Service(1,2) Temperature (Degrees F)		Common Uses(3)
	Push-On Gaskets	Mechanical Joint Gaskets	
SBR (Styrene Butadiene)	150 Degrees	120 Degrees	Fresh Water Salt Water Sanitary Sewage
EPDM (Ethylene Propylene)	250 Degrees	225 Degrees	Fresh Water Salt Water Sanitary Sewage Hot Water
Nitrile (NBR) (Acrylonitrile Butadiene)	150 Degrees	120 Degrees Fats, Oils Greases Chemicals	Hydrocarbons
Neoprene(R) (CR) (Polychloroprene)	200 Degrees	200 Degrees Salt Water Sanitary Sewage	Fresh Water
Viton(R); Fluorel(R) (FPM) (4) (Fluorocarbon)	300 Degrees	225 Degrees Acids Petroleum Vegetable Oils	Hydrocarbons

(1) Maximum service temperatures listed are intended as general guidelines for ductile iron pipe gaskets. For service temperatures greater than those listed, consult manufacturers for specific recommendations.

(2) Minimum service temperature is not usually a meaningful parameter for piping gaskets; however, low temperatures during pipeline installation may necessitate precautions. Consult manufacturer for pertinent recommendations.

(3) Water, including sanitary sewage, with low levels of the listed contaminants.

END OF SECTION 330519

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SECTION 330526 - UTILITY IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal utility markers.
   2. Trace wire for placement above direct-buried utility.

B. Related Requirements:
   1. Section 312333 “Trenching and Backfilling.”
   2. Section 312000 “Earthwork.”
   3. Section 331116 “Site Water Utility Distribution Piping” for piping, valves, and appurtenances requiring identification marking.
   4. Section 333100 “Sanitary Sewerage Piping” for piping, valves, and appurtenances requiring identification marking.
   5. Section 333113 “Public Sanitary Utility Sewerage Piping” for piping, valves, and appurtenances requiring identification marking.
   6. Section 333400 “Sanitary Utility Sewerage Force Mains” for piping, valves, and appurtenances requiring identification marking.
   7. Section 334100 “Storm Utility Drainage Piping” for piping, valves, and appurtenances requiring identification marking.
   8. Section 334113 “Public Storm Utility Drainage Piping” for piping, valves, and appurtenances requiring identification marking.

1.2 SUBMITTALS

A. Section 013300 “Submittal Procedures” for requirements for submittals.

B. Product Data: Submit manufacturer's catalog information for each product required.

C. Samples: Submit one, utility marker 10 feet of trace wire electronic utility marker ball and locators.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.3 CLOSEOUT SUBMITTALS

A. Section 017700 “Closeout Procedures” for requirements for submittals.

B. Project Record Documents: Record actual locations of tagged valves.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017700 “Closeout Procedures” for requirements for maintenance materials.

1.5 QUALITY ASSURANCE

A. Conform to APWA Uniform Color Code, ANSI Z535.1, and ASME A13.1 for color scheme for identification of piping systems and accessories.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

PART 2 - PRODUCTS

2.1 UTILITY MARKERS

A. Manufacturers:
   1. Berntsen International Inc.
   2. William Frick & Company.
   3. Substitutions: As specified in Section 016000 “Product Requirements” [**Not permitted**].

B. Metal:
   1. Material: Bronze.
   2. Diameter: 2 inches.
   3. Stem: 3/4 by 2 inches.

2.2 TRACE WIRE

A. Manufacturers:
   1. Northtown Company.
   2. Priority Wire and Cable, Inc.
   3. Tracerwire.
   4. Substitutions: As specified in Section 016000 - Product Requirements.
   5. Description:
      a. Conductor: Magnetically detectable.
      b. Covering: Brightly colored plastic, imprinted with “City of Flint” in large letters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipeline Marker Posts, Utility Markers, and Marking Flags: As recommended by manufacturer.

B. Trace Wire:
   1. Continuous buried 6 inches below finish grade, above piping.

2. If multiple pipes occur in common trench, locate wire above centerline of trench.
3. Place Trace Wire in the correct orientation, and anchor as necessary to prevent dislocation during placement of backfill.
4. Backfill above Trace Wire taking care to avoid dislocation. Compaction equipment shall not directly contact the Trace Wire.
5. Coordinate with trench Work as specified in Section 312333 “Trenching and Backfilling”.

END OF SECTION 330526

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SECTION 331116 - SITE WATER SAMPLING LINE

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. All labor, materials, equipment and incidentals required to install a Site Water Sampling Line, including an approximate 2-inch pressure tap on the existing 48-inch Prestressed Concrete Cylinder Pipe (PCCP), with a minimum bore of 1-3/8-inch, a 1-1/4-inch ball valve with threaded service connection, and a 3/4-inch retractable sampling probe, flexible chemical hose, and related fittings and equipment as shown on the Drawings.
   2. Underground pipe markers.
   3. Bedding and cover materials.

B. Related Requirements:
   1. Section 033000 “Cast-in-Place Concrete”
   2. Section 330513 “Manholes and Structures”
   3. Section 310515 “Soils and Aggregates for Earthwork” for soils and aggregate for backfill in trenches.
   4. Section 312333 “Trenching and Backfilling”

1.3 ACTION SUBMITTALS

A. Section 013300, “Submittal Procedures” for submittals requirements.

B. Product Data: Pipe materials, pipe fittings, valves, accessories, retractable sampling probe and flexible chemical hose.

C. Complete step-by-step descriptions of the methods to install the tap including required operating pressure of the 48-inch pipeline during tapping operation.

D. Complete drawings showing the location of the existing pipelines and showing both the proposed location of the test pit and pressure tap.

E. Complete detail drawings of the proposed pipe tapping equipment showing equipment and fitting positioning and overall dimensions and weight.

F. Statement indicating the design pressure rating of the tapping sleeves, tapping machine, and equipment.

G. List of experience with similar pipe materials and sizes.

H. Contractor field obtained information including circumference of the 48-inch pipeline, and the diameter and wire count of the high-tensile wire wrap

I. Operating and maintenance instructions on each type of equipment shall be submitted to Engineer as specified in Section 13300. Prepare instructions specifically for this installation and shall include catalog cuts, drawings, equipment lists, and descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.4 DESCRIPTION OF SYSTEM

A. Tapping shall be performed upon the pipeline as specified herein in such a manner that service in the pipelines shall not be affected. Flow in the pipelines shall not be stopped, and the pipelines shall not be drained during any portion of the tapping operation.

B. The tapping operation shall be performed on the 48-inch PCCP pipeline as shown on the Drawings. The anticipated operating pressure along the 48-inch water pipeline typically ranges between 105 psi to 75 psi. The existing 48-inch PCCP was installed in the 1960's. The pipeline was design for a working pressure of 75 psi, surge pressure of 105 psi. The Contractor is responsible for obtaining the Thompson Pipe Group design sheet which includes pertinent design information.

C. The Contractor is responsible for providing a safe excavation area that is large enough to accommodate the test pit and tapping operations. Site of the excavation should be coordinated with the approved pressure tap specialty subcontractor.

1.5 INFORMATIONAL SUBMITTALS

A. Obtain certified statement of approval of installation from supplier prior to energizing system.

B. Field Quality Control Submittals: Results of Contractor-furnished tests and inspections.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 "Closeout Procedures" for submittals requirements.

B. Project Record Documents: Actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Perform Work according to standards set by authorities having jurisdiction.

B. Maintain a copy of each standard affecting Work of this Section on Site.

C. The Contractor shall employ a specialty subcontractor as approved by the Engineer, to perform the tapping work. The specialty subcontractor shall have demonstrated experience with tapping work on pipelines of similar materials and size to the pipelines on

this project. Submit evidence that specialty subcontractor has completed a minimum of five taps on pipelines of similar materials and size to this project within the past eight years. Evidence of specialty subcontractor's experience shall be submitted with shop drawing submittals

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000, "Product Requirements" for transporting, handling, storing, and protecting products requirements.

B. Unload, store, and handle site water utility distribution piping according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 WATER PIPING

A. Copper Tubing: Per ASTM B88. Type K, annealed.
   1. Fittings: ASME B16.18, cast copper.
   2. Joints: Compression connection.

2.2 TAPPING SLEEVES AND VALVES

A. Flanged Tapping Sleeves for PCCP:
   1. Material:
      a. Saddle Plate shall be manufactured from ASTM A283 Grade C Steel or equal.
      b. Straps shall be manufactured from ASTM A 276 Type 304 Stainless Steel.
      c. Gasket shall have a broad, flat sealing surface and shall be manufactured of a material suitable for the intended conveyed fluid.
      d. Flange to be connected to valve shall be manufactured in accordance with AWWA C207 Class D. Flanges larger than 12" diameter shall have an alignment recess suitable for accepting the alignment lip of the tapping valve.
      e. Waterway shall be lined with fusion-bonded epoxy to a minimum thickness of l5 mils in accordance with AWWA C2l3.
      f. All other steel shall be coated with a fusion-bonded epoxy coating.
      g. Bolts, studs and nuts shall be stainless steel 18-8 type 304.
   2. Features
      a. Sleeve shall be designed for an operating pressure of 150 psi.
      b. The sleeve shall have a separate gland, which allows the sleeve to be installed, and the annular space between the pipe and the sleeve to be grouted, prior to cutting the prestressed wires.
      c. Foam or rubber grout gaskets and hard rubber spacers shall be used to provide an annular space between the pipe and the sleeve. Grout horns shall be furnished to facilitate grouting of the annular space.

      d. The annular space shall be grouted with a suitable Portland Cement grout. The grout shall be allowed to set prior to cutting any prestressing wires. Any accelerant used in the grout shall not be deleterious to prestressing wire.

e. The pressure plate shall be adequately braced to eliminate vibration & flexing of the plate while the tapping machine is operating.
f. The machined gasket groove on the pressure plate must be consistently positioned about throat of tapping gland waterway. However, ID of the gasket groove must be set back a minimum of 1" from the waterway to allow dispersal of forces generated by gasket compression. Gasket grooves machined in a circle and then rolled to an elliptical shape will not be allowed.
g. All waterway welds shall be dye-penetrant inspected or hydrostatically shop tested for water tightness.
h. The gland shall be equipped with load bearing set screws to transfer thrust loads from the branch piping to the sleeve.
i. A three-flange configuration shall be used on all outlets above twelve-inch to allow for valve bypass.
j. Welding the gland to the steel cylinder of the pipe to provide a watertight seal shall not be permitted.
k. The sleeve shall be encased in a minimum of one inch of Portland cement mortar or concrete for corrosion protection after the tap.
l. The sleeve shall be Thompson Pipe Group or approved equal.Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

2.3 RETRACTABLE SAMPLING PROBE ASSEMBLY

A. Retractable sampling probe shall consist of a ball type corporation stop assembly with packing nut assembly; sampling probe with integrated floating ball type check valve assembly; stainless steel safety chain. Sampling probe length shall provide installed probe end located one third into pipe diameter and be as indicated on the plans as fabricated from SAF-T-FLO.

2.4 BALL VALVES

A. Manufacturers:
1. Substitutions: As specified in Section 016000, “Product Requirements.”
2. Furnish materials according to standards set by authorities having jurisdiction

B. Pipe Size 2 inch and Smaller: Brass body, TEFC-coated brass ball, rubber seats and stem seals, tee stem pre-drilled for control rod, compression inlet end, compression outlet with electrical ground connector, with control rod, valve box, and valve key.

C. General Service Ball Valves: Bronze body, resilient seated, full port, threaded two-piece bolted body type valves. Full floating, non-lubricated balls. Easily accessible and replaceable valve seats.
1. Manual Valves: Locking levers.
2. Body and Cap: Brass, ASTM B 30,
3. Ball and Stem: 316 stainless steel
4. Seats and Seals: Glass filled TFE.

D. Valve Operators: Quarter turn, manual lever.

E. Mark manufacturer's name and pressure rating on valve body.

2.5 UNDERGROUND PIPE MARKERS

A. Manufacturers:
   1. Substitutions: As specified in Section 016000, “Product Requirements.”
   2. Furnish materials according to standards set by authorities having jurisdiction.

B. Plastic Ribbon Tape: Brightly colored, continuously printed. 6 inches wide by 4 mil thick or larger.
   1. Manufactured for direct burial service.

C. Trace Wire: Electronic detection materials for nonconductive piping products.
   1. Unshielded, 10 gage, THWN-insulated copper wire.
   2. Conductive tape.

2.6 MATERIALS

A. Bedding and Cover:
   1. Bedding: Fill Type, as specified in Section 310515 “Soils and Aggregates for Earthwork”
   2. Cover: Fill Type, as specified in Section 310515 “Soils and Aggregates for Earthwork”

B. Soil Backfill from Above Pipe to Finish Grade:
   1. Soil Type, as specified in Section 310515 “Soils and Aggregates for Earthwork”
   2. Subsoil: No rocks over **6 inches** in diameter, frozen earth, or foreign matter.

2.7 ACCESSORIES

A. Concrete for Thrust Restraints: Concrete type as specified in Section 033000, “Cast-in-Place Concrete.”

B. Manhole and Cover: As specified in Section 330513, “Manholes and Structures.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution” for installation examination requirements.

B. Verify that building service connections and municipal utility water main sizes, locations, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Section 017300 “Execution” for installation preparation requirements.

B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, and remove burrs.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare pipe connections to equipment with flanges or unions.

E. Protect and support existing distribution piping and appurtenances as Work progresses.

3.3 INSTALLATION

A. Bedding:
1. Excavate pipe trench as specified in Section [312333**, "**Trenching and Backfilling**."**]
2. Place bedding material at trench bottom.
3. Level fill materials in continuous layers not exceeding 8 inch compacted depth.
4. Compact to 95 percent of maximum density.
5. Backfill: Around sides and to top of pipe with cover fill, tamp in place, and compact to 95 percent of maximum density.

B. Piping:
1. Maintain separation of water main from sewer piping according to 10 states standards code.
2. Group piping with other Site piping work whenever practical.
3. Install pipe to elevations indicated on Drawings.
4. Install ductile iron piping and fittings: in accordance with requirements of the manufacturer and according to AWWA C600 or as otherwise provided herein.
5. Install PVC piping and fittings in accordance with requirements of the manufacturer and according to AWWA C605 or as otherwise provided herein.
6. As soon as the excavation is complete to normal grade of the bottom of the trench:
   a. place, compact and grade bedding to provide firm, uniform and continuous support for the pipe.
   b. Excavate bell holes so that only the barrel of the pipe bears upon the bedding. Blocking under the pipe will not be permitted.
   c. Place bedding evenly on each side of the pipe to mid-diameter and use hand tools to force the bedding under the haunches of the pipe and into the bell holes
   d. Place bedding shall to 12 inch above the top of the pipe.
   e. Place backfill above the bedding; placing the initial 3 feet of backfill above the bedding in 1-foot compacted layers.
   f. Do not operate directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe.
7. Close ends of the pipe with watertight plugs when installation is not in progress. Prevent deflection, using joints or fittings as required when crossing other utilities.
8. Cut pipes by machine only, leaving a smooth cut at right angles to the axis of the pipe. Bevel pipe to conform to bevels.
9. Check pipe to ensure proper connection with adjoining pipe. Match inverts and grade.
10. Do not drive pipe to grade with excessive force that could damage the pipe. Take all steps to prevent from floating in the trench.
11. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, prevent moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill.
12. Do not extend trench boxes, moveable sheeting, shoring or plates to extend below top of the pipe.
13. Repair or replace defective pipe.

C. Joints:

1. For push-on type PVC pipe:
   a. Lay pipewith bell ends looking ahead.
   b. Insert a rubber gasketin the groove of the bell end of the pipe and clean and lubricate joint surfaces.
   c. Inset the plain end in alignment with the bell and pushed into place.
   d. Check that the reference mark on the spigot end is flush with the end of the bell.
2. Install grooved and shouldered pipe joints according to AWWA C606 Mechanical joints at valves, fittings, hydrants and where designated shall be in accordance with the AWWA C111 and the instructions of the manufacturer. Suitable PVC to cast iron adaptors shall be installed prior to installing fittings. PVC beveled spigot shall be cut flush prior to insertion in mechanical joint pipe. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage.
3. Route pipe in straight line.
4. Install access fittings to permit disinfection of water system performed under Section [330519, “Ductile Iron Utility Pipe for Water Service.”]
5. Thrust Restraints:
   a. Form and place concrete for pipe thrust restraints at each elbow or change of pipe direction.
   b. Place concrete to permit full access to pipe and pipe accessories.
   c. Establish elevations of buried piping with not less than 4 feet of cover.

D. Disinfection Procedure: Flush and disinfect system as specified in Section 330519, “Ductile Iron Utility Pipe for Water Service.”

3.4 TOLERANCES

A. Section 014000, “Quality Requirements” for tolerances requirements.

B. Install pipe within tolerance of 5/8 inch.

3.5 FIELD QUALITY CONTROL

A. See Section 014000 “Quality Requirements” for inspecting and testing requirements See Section 017300 “Execution” for testing, adjusting, and balancing requirements.

B. Pressure Test System According to AWWA C600 and following:
1. Test Pressure: 200 psig or 50 psi in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for at least two hours.
3. Slowly fill with water section to be tested and expel air from piping by installing corporation cocks at high points.
4. Close air vents and corporation cocks after air is expelled and raise pressure to specified test pressure.
5. Observe joints, fittings, and valves under test. Remove and renew cracked pipes, joints, fittings, and valves showing visible leakage and retest.
6. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
7. Maintain pressure within plus or minus 5 psi of test pressure.

8. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
9. Compute maximum allowable leakage using the following formula: L = SD x sqrt(P)/C. When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
    a. L: Testing allowance, in gph
    b. S: Length of pipe tested, in feet
    c. D: Nominal diameter of pipe, in inches
    d. P: Average test pressure during hydrostatic test, in psig
    e. C: 148,000
10. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
11. Correct visible leaks regardless of quantity of leakage.

C. Compaction Testing for Bedding: Comply with ASTM D1557.

D. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

3.6 PCCP Tapping Sleeve and Threaded Service Valve Installation

1. The Contractor is responsible for determining the circumference of the pipe in the proposed area of the tapping sleeve so that the tapping saddle can be manufactured to the proper dimensions for the pipe. This work shall include excavating a test pit in the general vicinity of the tapping saddle location to physically measure the circumference. This work is required prior to installation to prior to installation to ensure compatibility of tapping materials and equipment.

2. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three feet from a pipe joint. The exact location of the tap is subject to approval by the Engineer.

3. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be not less than ¼-inch less than the inside diameter of the line.

4. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves and experienced in pressure tapping PCCP. The equipment shall be furnished by the Contractor.

5. The work to accomplish the successful pressure tapping of the 48-inch PCCP, will require several steps over a few days as can be seen in prestressed concrete cylinder pipe manufacturer's literature for tapping prestressed concrete cylinder pipe. The contractor shall demonstrate knowledge of the requirements and procedure stated in the literature which shall be included as part of the submittal in Section 1.3, above. Under no circumstances will any work proceed for the pressure tapping of the pipe without assurances from the Owner that the maximum operating pressure for the 48-inch PCCP will be maintained below 50-psi for the required duration of the work.

6. Tapping sleeves will be installed per manufacturer's specifications and instructions. Follow manufacturer's instructions pertaining to the installation of the tapping sleeve and tapping saddle. All tapping sleeves or saddles installed on concrete pipe shall be encased in mortar or concrete per manufactures instructions.

7. Prior to completing the tap, all components that will come into contact with potable water shall be swabbed with chlorine solution to ensure that they are disinfected. All proper regulatory procedures shall be followed exactly.

END OF SECTION 331116

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SECTION 333100 - SANITARY UTILITY SEWERAGE PIPING

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. Sanitary sewerage gravity piping.
2. Pipe markers.
3. Bedding and cover materials.

B. Related Requirements:
1. Section 033000 “Cast-In-Place Concrete” for concrete type for manhole base pad construction.
2. Section 036000 “Grouting” for non-shrink grout.
3. Section 040514 “Masonry Mortaring and Grouting” for masonry grout.
4. Section 221316 “Sanitary Waste and Vent Piping” for product and execution requirements for sanitary waste and vent piping at building.
5. Section 310515 “Soils and Aggregates for Earthwork” for soils and aggregate for backfill in trenches.
6. Section 315000 “Excavation Support and Protection” for product and execution requirements for excavation and backfill required by this Section.
7. Section 312333 “Trenching and Backfilling” for requirements for backfill to be placed by this Section.
8. Section 330526 “Utility Identification” for pipe markers.
9. Section 330513 “Manholes and Structures.”

1.3 DEFINITIONS

A. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.

1.4 COORDINATION

A. Section 013100 “Project Management and Coordination” for coordination requirements.

B. Coordinate Work of this Section with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

C. Notify affected utility companies at least 72 hours prior to construction.

1.5 PREINSTALLATION MEETINGS

A. Section 013100 “Project Management and Coordination” for preinstallation meeting requirements.

B. Convene minimum one week prior to commencing Work of this Section.

1.6 ACTION SUBMITTALS

A. Section 013300, “Submittal Procedures” for submittals requirements.

B. Product Data: Submit manufacturer catalog cuts and other information indicating proposed materials to be used, accessories, details, and construction information.

C. Shop Drawings: Showing layout and details of pipe, reinforcement, joints, gaskets, special fittings and the name of the pipe manufacturer. A schedule of pipe lengths (including the length of individual pipes by diameter) for the entire job.

D. Permits: Submit copies of any required construction permits

1.7 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Products meet or exceed specified requirements.

B. Manufacturer Instructions: Special procedures required to install specified products.

C. Prior to each shipment of pipe, submit certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM Standards specified herein.

D. Submit information on quality control testing including dimensional drawings of any mandrels or other ovality testing equipment.

E. Field Quality-Control Submittals: Results of Contractor-furnished tests and inspections.

1.8 CLOSEOUT SUBMITTALS

A. Section 017700 “Closeout Procedures” for closeout procedures requirements.

B. Project Record Documents: Record locations of pipe runs, connections, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.9 QUALITY ASSURANCE

A. Perform Work according to all relevant standards.

B. Inspections of the pipe may also be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

C. Maintain 3 copies of each standard affecting Work of this Section on Site.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 016000, “Product Requirements” for transporting, handling, storing, and protecting products requirements. Refer to specific pipe material sections for additional information.

B. Inspection: Accept materials on Site in manufacturer’s original packaging and inspect for damage.

C. Storage: Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Block individual and stockpiled pipe lengths to prevent moving.
3. Provide additional protection according to manufacturer instructions.
4. Protect materials from weather and UV exposure.

1.12 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Field verify fit-up to existing infrastructure prior to fabrication.
3. Document field measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 SANITARY SEWERAGE PIPING & CASING FOR CHEMICAL TUBING

A. Ductile-Iron Pipe: Per AWWA C150 or AWWA C151.
1. Minimum Pressure Class: 350.
2. Minimum Special Thickness Class: 54.

3. End Connections: Bell and spigot.
4. Outside Coating Type: Asphaltic coating, minimum 1 mil uniform thickness. Per AWWA C151.
5. Lining: Protecto 401 ceramic epoxy lining.
   a. Seal coating applied at the following thickness:
      1) Nominal Pipe Sizes 6 inches through 12 inches: 1/8 inch.
6. Fittings: Ductile iron.
7. Joints: Rubber gasket joint devices per AWWA C111.

B. Plastic Pipe: Polyvinyl chloride (PVC) per ASTM D3034, SDR-26.
1. Inside Nominal Diameter: 4 inches.
2. End Connections: Bell and spigot style, with rubber-ring-sealed gasket joint.
3. Fittings: PVC.
4. Joints: Elastomeric gaskets per ASTM F477.

2.2 MATERIALS

A. Bedding and Cover:
1. Bedding: For Solid Wall PVC, place MDOT 21AA Limestone to 1’ over top of pipe. For Ductile Iron Sanitary Sewer, place MDOT 21AA Limestone to springline of the pipe and backfill with MDOT Class II Sand to 1’ over top of pipe.
2. Soil Backfill from Above Pipe to Finish Grade as indicated on the plans

2.3 ACCESSORIES

A. Pipe Markers: As specified in Section 330526, “Utility Identification.”

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution” for installation examination requirements.

B. Verify that excavation base is ready to receive Work.

C. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

A. Section 017300 “Execution” for installation preparation requirements.

B. Correct over-excavation with coarse aggregate.

C. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.

D. Protect and support existing sewer lines, utilities, and appurtenances.

E. Utilities:
1. Maintain profiles of utilities.
2. Coordinate with other utilities to eliminate interference.
3. Notify Engineer if crossing conflicts occur.

3.3 INSTALLATION:

A. Bedding:
1. Excavate pipe trench as specified in Section 312333 Trenching and Backfilling
2. Place bedding material at trench bottom according to pipe manufacturers specifications.
3. Level materials in continuous layer not exceeding 6 inches.
4. Maintain optimum moisture content of bedding material to attain required compaction density.

B. Piping:
1. Install pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
2. Lay pipe to slope gradients as indicated on Drawings.
3. Maximum Variation from Indicated Slope: 1/8 inch in 10 feet. Install pipe with a negative / downward oriented slope unless explicitly stated in the Drawings.
4. Install bedding at sides and over top of pipe, to minimum compacted thickness of 12 inch.
5. Backfill and compact as specified in Section 312333 “Trenching and Backfilling”
6. Do not displace or damage pipe when compacting.
7. Connect to building sanitary sewer outlet and municipal sewer system through installed sleeves.
8. Pipe Markers: As specified in Section 330526, “Utility Identification.”
9. Install Site sanitary sewage system piping to within 5 feet of building, and connect to building sanitary waste system as specified in Section 221316 “Sanitary Waste and Vent Piping”

3.4 FIELD QUALITY CONTROL

A. Section 014000, “Quality Requirements” for inspecting and testing requirements Section 017300 “Execution” for testing, adjusting, and balancing requirements.

B. Request inspection by Engineer prior to and immediately after placing bedding.

C. Testing: If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.

D. Testing of Gravity Sewer Piping:
1. Low Pressure Air Testing:
a. Test each reach of gravity sewer piping between manholes.
b. Introduce air pressure slowly to approximately 4 psig.
1) Determine ground water elevation above spring line of piping.
2) For every foot of ground water above spring line of piping, increase starting air test pressure by 0.43 psi.
3) Do not increase pressure above 10 psig.

c. Allow pressure to stabilize for at least five minutes.
d. Adjust pressure to 3.5 psig or to increased test pressure as determined above when ground water is present.
e. Testing: Determine test duration for reach of sewer with single pipe size from following table; do not make allowance for laterals.

NOMINAL PIPE SIZE, **INCHES**	MINIMUM TESTING TIME, MINUTES/**100 FEET**
3	0.2
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

1) Record drop in pressure during testing period.
2) Test Acceptance: If 1.0 psi air pressure drop has not occurred during testing period, piping is acceptable; discontinue testing.
3) Test Failure: If air pressure drops more than 1.0 psi during testing period pipe has failed.
a) If piping fails, test reach of piping in incremental stages until leaks are isolated, repair leaks, and retest entire reach between manholes.

2. Exfiltration Testing: Pipes Larger than 36 inches in diameter:
a. Maximum Allowable Exfiltration: 100 gal/inch of pipe diameter for each mile per day for each reach of piping undergoing testing.
b. Perform testing with minimum positive head of 2 feet.
3. Infiltration Testing:
a. Maximum Allowable Infiltration: 100 gal./inch of pipe diameter for each mile per day for reach of piping undergoing testing.
b. Include allowances for leakage from manholes.
c. Perform testing with minimum positive head of 2 feet.
4. Deflection Testing of Plastic Sewer Piping:
a. Vertical Ring Deflection Testing: On PVC and acrylonitrile butadiene styrene sewer piping after backfilling has been in place for 30 days but not longer than 12 months.
b. Allowable Maximum Deflection: For installed plastic sewer pipe; not greater than 5 percent of original vertical internal diameter.
c. Deflection Testing: Using properly sized rigid ball or "go, no go" mandrel.
1) Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe, as determined by ASTM standard to which pipe is manufactured.

2) Measure pipe diameter in compliance with ASTM D2122.

d. Perform testing without mechanical pulling devices.

e. Locate, excavate, replace, and retest piping that exceeds allowable deflection.

5. Compaction Testing:

a. Comply with ASTM D1557.

3.5 PROTECTION

A. Section 017300 “Execution” for protecting finished Work requirements.

B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

3.6 ATTACHMENTS

END OF SECTION 333100

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SECTION 400506 - COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

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. Pipe penetrations.
2. Restrained joints.
3. Flexible connections.
4. Expansion joints.
5. Expansion loops.
6. Sleeve-type couplings.

B. Related Requirements:
1. Section 055000 - Metal Fabrications: Miscellaneous metalwork and fasteners as required by this Section
2. Section 078443 - Firestopping: Penetrations through fire-rated materials
3. Section 079200 - Joint Sealers
4. Section 099100 - Painting and Coating: Product and execution requirements for painting specified by this Section
5. Section 330519 - Pressure Piping Tied Joint Restraint System: Pipe restraints
6. Section 400507 - Hangers and Supports for Process Piping: Hangers, anchors, sleeves, and sealing of piping to adjacent structures
7. Section 400519 - Ductile Iron Process Pipe: Ductile-iron piping materials and appurtenances
8. Section 400524 - Steel Process Pipe: Steel piping materials and appurtenances
9. Section 400531 - Thermoplastic Process Pipe: Plastic piping materials and appurtenances
10. Section 400551 - Common Requirements for Process Valves: Common product requirements for valves for placement by this Section

1.3 DEFINITIONS

A. Firestopping (Through-Penetration Protection System): The sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire-rated construction.

B. FM: Factory Mutual Insurance Company; FM Global is the communicative name of the company.

C. WH: Warnock Hersey; indicates compliance to relevant building codes, association criteria, and product safety and performance standards.

1.4 COORDINATION

A. Requirements for coordination are included in Section 013100 – Project Management and Coordination.

B. Coordinate Work of this Section with installation of piping, valves and equipment connections specified in other Sections and indicated on Drawings.

1.5 PREINSTALLATION MEETINGS

A. Requirements for preinstallation meeting are included in Section 013100 - Project Management and Coordination.

1.6 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:
1. Submit manufacturer catalog information for each specified product, including installation instructions.
2. Firestopping: Submit data on product characteristics, performance, and limitation criteria.
3. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
4. Expansion Joints: Indicate maximum temperature, pressure rating, and expansion compensation.

C. Shop Drawings:
1. Identification:
   a. Submit list of wording, symbols, letter size, and color coding for pipe identification.
   b. Comply with ASME A13.1.
2. Indicate restrained joint details and materials.
3. Submit layout drawings showing piece numbers and location, indicating restrained joint locations.
4. Indicate layout of piping systems, including flexible connectors, expansion joints and compensators, loops, offsets, and swing joints.

D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings for maintenance of fire-resistance rating of adjacent assembly.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for:
   1. Flexible connectors
   2. Expansion joints
   3. Pipe Restraints:
      a. Determine restrained lengths and submit joint restraint details.
      b. Use joint restraint devices specifically designed for applications as described in manufacturer data.
   4. Firestopping Engineering Judgments: For conditions not covered by UL- or WH-listed designs, submit judgments by licensed professional engineer suitable for presentation to authority having jurisdiction to accept as meeting fire-protection code requirements.

H. Manufacturer Instructions: Submit special procedures and setting dimensions.

I. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

K. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.
   3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.
   4. American Iron and Steel (AIS): Submit certification indicating compliance with requirements.

1.7 CLOSEOUT SUBMITTALS

A. Section 017700 “Closeout Procedures”: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping appurtenances.

C. Identify and describe unexpected variations to pipe routing or discovery of uncharted utilities.

1.8 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

B. Perform Work according to ASME B31.9 for installation of piping systems and according to AWS D1.1/D1.1M for welding materials and procedures.

C. Perform Work according to ASME B31.3 and ASME B31.9 for installation of piping systems.

D. Through-Penetration Firestopping of Fire-Rated Assemblies:
   1. Comply with UL 1479 or ASTM E814.
   2. Minimum Positive Pressure Differential: 0.1-inch wg to achieve fire F-ratings and temperature T-ratings as indicated on Drawings, but not less than one hour.
   3. Wall Penetrations: Fire F-ratings as indicated on Drawings, but not less than one hour.

4. Floor and Roof Penetrations:
   a. Fire F-ratings and Temperature T-ratings: As indicated on Drawings, but not less than one hour.
   b. Floor Penetrations within Wall Cavities: T-rating is not required.

E. Through-Penetration Firestopping of Non-fire-rated Floor and Roof Assemblies:
1. Materials to resist free passage of flame and products of combustion.
2. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
3. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.

F. Fire-Resistive Joints in Fire-Rated Floor, Roof, and Wall Assemblies:
1. Comply with ASTM E1966 or UL 2079.
2. Rating: As indicated on Drawings for assembly in which joint is installed.

G. Fire-Resistive Joints between Floor Slabs and Exterior Walls:
1. Comply with ASTM E119.
2. Minimum Positive Pressure Differential: 0.1-inch wg to achieve fire-resistance rating as indicated on Drawings for floor assembly.

H. Surface-Burning Characteristics: Maximum 25/450 flame-spread/smoke-developed index when tested according to ASTM E84.

I. Maintain one (1) copy of each standard affecting Work of this Section on Site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
3. Provide additional protection according to manufacturer instructions.

1.11 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Section 017700 “Closeout Procedures”: Requirements for warranties.

PART 2 - PRODUCTS

2.1 PIPE PENETRATIONS

A. Performance and Design Criteria:
   1. Firestopping Materials: As specified in Section 078400 - Firestopping.
   2. Firestop interruptions to fire-rated assemblies, materials, and components.
   3. Firestopping: Provide certificate of compliance from authority having jurisdiction, indicating approval of materials used.

2.2 PIPE SLEEVES

A. All construction except new concrete walls:
   1. Material: Schedule 40 galvanized steel conforming to ASTM A53.
   2. 2-inch minimum circumference water stop welded to exterior sleeve at midpoint
   3. Ends cut and ground to be:
      a. Flush with ground
      b. Flush with ceiling
      c. 2 inches above finished floors
      d. Sealed with caulking
      e. Sized as required.

B. New concrete walls with pipes up to 20 inches in diameter:
   1. Material: non-metallic High-Density Polyethylene Sleeves (HDPE)
   2. Integral hollow molded water stops
      a. 4 inches larger than the outside diameter of the sleeve.
   3. End caps for forming and reinforcing ribs.
   4. Domestically manufactured by:
      a. Century-Line as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or equal.

C. New concrete with pipes 20 to 60 inches in diameter:
   1. Material: molded HDPE modular interlocking discs to make the width of the wall
      a. Corrugated
      b. Cell-Cast as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or equal.

D. External wall penetrations:
   1. 36 -in diameter and less may be made by means of a ductile iron sleeve capable of being bolted directly to the formwork:
   2. Seal of the annular space between the carrier pipe and the sleeve made by means of a confined rubber gasket and be capable of withstanding 350 psi.:
   3. Sleeve to have an integrally cast waterstop of 1/2-in minimum thickness, 2-1/2-in minimum height.
   4. Manufacturers: Omni-Sleeve, Malden, MA or equal.

2.3 WALL CASTINGS

A. Ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53.

B. Diameter as required.

C. Flanges and/or mechanical joint bells drilled and tapped for studs where flush with the wall.

D. Castings provided with a 2-in minimum circumferential flange/waterstop integrally cast with or welded to the casting.

E. Located as follows:
   1. for castings set flush with walls: located at the center of the overall length of the casting,
   2. for castings which extend through wall: located within the middle third of the wall.

2.4 SEALING MATERIALS

A. Mechanical seals:
   1. Of rubber links shaped to continuously fill the annular space between the pipe and the wall opening or sleeve.
   2. Link pressure plates molded of glass reinforced nylon:
      a. colored throughout elastomer,
      b. permanent identification of the size and manufacturer's name molded into the pressure plate and sealing element.
   3. Hardware:
      a. Mild steel with a 60,000 psi minimum tensile strength
      b. 2-part Zinc Dichromate coating per ASTM B-633
      c. Organic Coating, tested in accordance with ASTM B-117 to pass a 1,500-hour salt spray test.
      d. Use Type 316 Stainless Steel hardware:
         1) in chemical areas
         2) for submerged service
         3) for penetrations in tanks containing sludge or wastewater.
   4. Completed sealing system:

a. Duty pressure rated for 20 psig differential pressure.
b. EPDM for all services except fire rated assemblies
   1) fire rated seals use silicone link material.
c. Manufacturer: PSI-Thunderline/ Link-Seal as manufactured by Pipeline Seal & Insulator, Inc., Houston, TX, or pre-approved equal.

B. Sealant:
1. A two-part foamed silicone elastomer manufactured by:
   a. Dow Corning Co., Product No. 3-6548 silicone R.T.V.
   b. 3M brand fire barrier products caulk C.P. 25 and 3M brand moldable putty MP+;
   c. Flame-Safe fire stop systems FS-900 by Rectorseal.
2. Sealant bead configuration, depth and width in accordance with manufacturer's recommendations.

2.5 MISCELLANEOUS MATERIALS

A. Bonding compound:
1. Sikadur Hi-Mod epoxy by Sika Corp.;
2. Euco 452 by Euclid Chemical Corp.; Master Builders Company
3. or equal.

B. Non-shrink grout:
1. Masterflow 713 by Master Builders Co.;
2. Euco NS by Euclid Chemical Co.;
3. Five Star Grout by U.S. Grout Corp.
4. or equal.

2.6 FLEXIBLE CONNECTIONS

A. Manufacturers:
1. For pressure pipe applications and applications with steel and copper piping: Flexicraft Industries, Chicago, IL; Hyspan Precision Products, Inc.; Metraflex Company, Chicago, IL; Victaulic Company, Easton, PA or equal.
2. For non-pressurized applications involving plastic, clay, asbestos cement, or cast iron applications: Fernco or equal.
3. Substitutions: As specified in Section 016000 - Product Requirements.

B. Steel Piping:
1. Inner Hose: Carbon steel Exterior Sleeve: . Single-braided
2. Pressure Rating: 125 psig WSP at 450 degrees F 200 psig WOG at 250 degrees F.
3. Joints: FlangedSize: Use pipe-sized units.
4. Maximum Offset: [3/4] inch on each side of installed center line.

C. Copper Piping:
1. Inner Hose: Bronze.
2. Exterior Sleeve: Braided bronze.
3. Pressure Rating: 125 psig WSP at 450 degrees F 200 psig WOG at 250 degrees F.
4. Joints: Flanged Soldered.
5. Size: Use pipe-sized units.

6. Maximum Offset: ¾-inch on each side of installed center line.

D. Non-Pressurized Piping (Plastic, Clay, Asbestos Cement, Cast Iron utilized under 4.3 psig)
1. Flexible couplings: in accordance with ASTM D 5926, C1173 and CSA B602.
2. Couplings: rubberized PVC and be attached with the use of adjustable stainless steel clamps.

2.7 SLEEVE-TYPE COUPLINGS

A. Manufacturers:
1. GE Oil & Gas (Dresser); Xylem (Smith-Blair) or equal.
2. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Comply with AWWA C213, C219.
2. Middle Ring: Steel Ductile iron.
3. Followers: Steel Ductile iron.
4. Gaskets:
a. Material: Compatible with service conditions.
b. Comply with ASTM D2000.
5. Bolts: 316 Stainless Steel.

C. Finishes:
1. Factory fusion bonded epoxy coated.

2.8 FINISHES

A. Prepare piping appurtenances for field finishes as specified in Section 099100 - Painting.

2.9 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.
1. Provide shop inspection and testing of completed assemblies.

B. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution”: Requirements for installation examination.

B. Verify that field dimensions are as indicated on the Drawings.

C. Inspect existing flanges for nonstandard bolthole configurations or design and verify that new pipe and flanges mate properly.

D. Verify that openings are ready to receive sleeves and firestopping.

E. Verify that pipe plain ends to receive sleeve-type couplings are smooth and round for 12 inches from pipe ends.

F. Verify that pipe outside diameter conforms to sleeve manufacturer's requirements.

3.2 PREPARATION

A. Section 017300 “Execution”: Requirements for installation preparation.

B. Cleaning: Thoroughly clean end connections before installation.

C. Close pipe and equipment openings with caps or plugs during installation.

D. Surface Preparation: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to ASME B31.3 and ASME B31.9.

B. Coating: Finish piping appurtenances as specified in Section 099100 - Painting for service conditions.

C. Pipe Penetrations:
   1. Flashing:
      a. Provide flexible flashing and metal counterflashing where piping penetrates weatherproofed or waterproofed walls, floors, and roofs.
      b. Flash floor drains with topping over finished areas with lead, 10 inches clear on sides, with minimum 36-by-36-inch sheet size.
      c. Fasten flashing to drain clamp device.
   2. Sleeves:
      a. Exterior Watertight Entries: Seal with mechanical sleeve seals.
      b. Set sleeves in position in forms and provide reinforcement around sleeves.
      c. Size sleeves large enough to allow for movement due to expansion and contraction and provide for continuous insulation wrapping.
      d. Extend sleeves through floors 1 inch above finished floor level and calk sleeves.
      e. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent Work with firestopping insulation and calk airtight.
      f. Provide close-fitting metal collar or escutcheon covers at both sides of penetration.
      g. Install plastic escutcheons at finished surfaces.

D. Firestopping:
   1. Install material at fire-rated construction perimeters and openings containing penetrating sleeves, piping, and other items requiring firestopping.

2. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
3. Apply firestopping material in sufficient thickness and to uniform density and texture to achieve required fire and smoke rating.
4. Placement: Compress fibered material to maximum 40 percent of its uncompressed size.

E. Restrained Joints: As specified in Section 330519 - Pressure Piping Tied Joint Restraint System.

F. Flexible Connections: Install flexible couplings at connections to equipment and where indicated on the Drawings.

G. Expansion Joints:
1. Install flexible couplings and expansion joints at connections to equipment and where indicated on the Drawings.
2. If expansion joint is supplied with internal sleeve, indicate flow direction on outside of joint.

H. Air Release and Vacuum Breakers: Provide vacuum breakers on all tanks and process equipment as indicated on Drawings.

I. Backflow Preventers:
1. Install with nameplate and test cock accessible.
2. Install according to local code requirements.
3. Do not install in vertical position.

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017300 - Execution: Requirements for testing, adjusting, and balancing.

C. After installation, inspect for proper supports and interferences.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Sections 017300 - Execution and 017700 - Closeout Procedures: Requirements for cleaning.

B. Keep equipment interior clean as installation progresses.

3.6 ATTACHMENTS

A. Pipe Schedule:
1. Ductile Iron:
   a. Material No.: 11
   b. Reference Standard: AWWA C115
   c. Joints:
      1) Type: Mechanical

2) AWWA C110 and C111.

d. Fittings:

1) Material: Ductile iron

2) AWWA C110.

e. Gaskets: Rubber

f. Test Pressure: 200 psig.

2. Copper:

a. Material No.: 17

b. Type: Seamless

c. Reference Standard: ASTM B251

d. Joints: Brazed

e. Fittings:

1) Material: Wrought copper

2) ASME B16.29.

f. Test Pressure: 200 psig.

3. PVC:

a. Material No.: 21

b. Reference Standard: ASTM D1785

c. Joints: Solvent weld

d. Fittings:

1) Material: Cast iron

2) AWWA C111.

e. Test Pressure: 125 psig.

END OF SECTION 400506

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SECTION 400507 - HANGERS AND SUPPORTS FOR PROCESS PIPING

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.

B. This specification requires Contractor to delegate pipe support design to a pipe support design engineer hired by the Contractor. Where the Drawings show support types and/or locations, they shall be analyzed for adequacy to support loads and stresses calculated by the pipe support designer, modified if required, installed generally where shown, and integrated with the pipe support system design provided by the Contractor.

C. Related Requirements:
1. Section 033000 - Cast-in-Place Concrete: Execution requirements for placement of concrete housekeeping pads specified by this Section.
2. Section 220719 - Plumbing Piping Insulation: Process piping insulation requirements.
3. Section 099100 - Painting and Coating: Product and execution requirements for painting specified by this Section.
4. Section 400506 - Couplings, Adapters, and Specials for Process Piping.
5. Section 400517 - Copper Process Pipe and Tubing
6. Section 400519 - Ductile Iron Process Pipe
7. Section 400524 - Steel Process Pipe

1.2 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.3 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog data including load capacity.

C. Shop Drawings: Submit scaled piping layouts for each system. Indicate flow stream, pipe size(s) material(s), schedule(s), lining(s), critical dimensions between pipes, equipment and building features. Indicate by schedule pipe hanger/support type and locations. Provide detail of each type of hangers, supports, anchors, and guides.

D. Delegated Design Submittals: Support System Design
   1. Engage the services of an independent registered professional engineer licensed in the State of Michigan ordinarily engaged in the business of pipe support systems analysis and design, to analyze system piping and service conditions, and to develop a detailed support system design, specific to the piping material, pipe joints, valves, and piping appurtenances proposed for use.
      a. The proposed support system engineer shall have at least 5 years of experience in the analysis and design of similar systems, including the use of commercial and custom pipe supports and in the use of commercial pipe stress software programs.
      b. Engineer pre-approved support system engineering groups include the following:
         1) J. Blanco Associates, Inc. Hawthorne, NJ
         2) Fenny Engineering Company, Venice, FL
         3) LCI Engineering, Ottawa, Ontario, Canada.
   2. The support system design shall include:
      a. Criteria by piping system.
      b. Summary of Contractor-selected related components including joints, class, valves, appurtenances, etc., and commercial supports and especially including pipe materials.
      c. Dead weight and dynamic analysis, including system thermal effects and pressure thrusts. Computer-based software system equivalent to Bentley Systems AutoPIPE or SST Systems CAEPIPE.
         1) Present each system in an isometric graphic and show the resolved and resultant force and moment systems, as well as all recommended hangers, supports, anchors, restraints, and expansion/flexible joints.
      d. Submit a support system design to the Engineer for review. The submittal needs to be stamped by a professional engineer registered in Michigan.
      e. All aspects of the analysis and design to comply with the provisions of ANSI B31.3 and the referenced standards.
      f. Coordinate support arrangements to eliminate interference with similar systems to be installed under HVAC, Plumbing, and Electrical; to account for structural expansion joints and to maintain access for both personnel and for the removal of equipment.

E. Manufacturers' Instructions: Submit special procedures and assembly of components.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Welders' Certificate: Submit welders' certification of compliance with AWS D1.1, verifying qualification within previous 12 months.

C. Qualifications Statements:

   1. Submit qualifications for manufacturer, fabricator, installer, and licensed professional.

2. Submit manufacturer's approval of installer.

1.6 DEFINITIONS

A. Ferrous Metal: Iron, steel, stainless steel, and alloys with iron as principal component.

B. Wetted or submerged: Submerged, less than 1-foot above liquid surface, below top of channel or tank wall, under cover or slab of channel or tank, or in other damp locations.

C. “Pipe” or “piping” shall mean all piping, piping system(s), hose, tube, fittings, joints, valves, and similar appurtenances.

D. Supports: wherever the word “supports” or “pipe supports” are used, they shall mean pipe supports, hangers, structural connections, concrete inserts (if allowed), anchors, guides, bolts, expansion units, restraints and all restraint, hanging, supporting, allowing controlled expansion, or other means of attaching piping along with the necessary appurtenances.

1.7 DELIVERY, STORAGE AND HANDLING

A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.

B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.

C. Finished metal surfaces not galvanized, that are not of stainless steel construction, or that are not coated, shall be grease coated, to prevent rust and corrosion.

1.8 QUALITY ASSURANCE

A. Perform Work according to AWS D1.1 for welding hanger and support attachments to building structure.

B. Perform Work according to City of Flint Department of Public Works standards.

C. Maintain copy of each standard affecting the Work of this Section on-site.

1.9 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.

C. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional Engineer experienced in design of specified Work and licensed in State of Michigan.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials onsite in original factory packaging, labeled with manufacturer's identification.

C. Protect products from weather and construction traffic, dirt, water, chemical, and damage by storing in original packaging.

1.11 EXISTING CONDITIONS

A. Field Measurements: Verify field measurements prior to fabrication. Indicate field measurements on Shop Drawings.

1.12 WARRANTY

A. Section 017700 - Closeout Procedures: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 GENERAL

A. Support pipe and appurtenances connected to equipment to prevent any strain being imposed on the equipment. Comply with manufacturer’s requirements regarding piping loads being or not being transmitted to their equipment. Submit certification stating that such requirements have been met.

B. Support and secure all pipe and tubing in the intended position and alignment to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances. Design all supports to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 055000 - Metal Fabrications and shall be furnished and installed under this Section.

C. Contractor may propose minor adjustments to the piping arrangements in order to simplify the supports, or in order to resolve minor conflicts in the work. Such an adjustment might involve minor change to a pipe centerline elevation so that a single trapeze support may be used.

D. Where flexible sleeve, split ring, vibration, or other couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported to prevent transfer of force systems to the equipment. Do not install fixed or restraining supports between a flexible coupling and the piece of equipment.

E. Pipe supports:
   1. Shall not induce point loadings but shall distribute pipe loads evenly along the pipe circumference.
   2. Provide supports at changes in direction and elsewhere as shown in the Drawings or as specified herein.
   3. No piping shall be supported from other piping or from metal stairs, ladders, and walkways, unless specifically directed or authorized by the Engineer.
   4. Provide pipe supports to minimize lateral forces through valves, both sides of flexible split ring type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.
   5. Effects of thermal expansion and contraction of the pipe to be accounted for in the pipe support selection and installation.

F. Insofar as is possible, floor supports shall be given preference. Where specifically indicated, concrete supports, as shown on the Drawings, may be used. Base elbow and base tees shall be supported on concrete pedestals.

G. Restraints, flexible connections, expansion items, and related items as included in other specifications (especially Sections 400524, 400531 and other individual pipe sections) and shown on the Drawings.

2.2 PERFORMANCE REQUIREMENTS/DESIGN CRITERIA

A. All supports and appurtenances shall be standard products from approved manufacturers wherever possible and shall be adequate to maintain the supported load in proper position under all operating conditions. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Note that different materials required, as specified in Part 2 MATERIALS, may require different figures or model numbers than those shown.
   1. The minimum working factor of safety for all items, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10 feet of water-filled pipe being supported and normal test pressures.
   2. Design for all loads using a safety factor of 5.

B. Piping schedule is included in the contract drawings.

C. All items shall be designed with strength and stiffness to support, restrain, and allow expansion of the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces.

D. Support spacing shall be per ASME B31.3 ASME 31.9 and MSS SP 58.

E. Complete design details of the pipe system components shall be submitted for review and approval as specified in Part 1. No support shall be installed without approved support system Drawings.

F. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

G. Seismic Design and restraint requirements, in accordance with the Structural Design criteria.

2.3 MATERIALS

A. For support of metallic pipe:
1. Submerged, buried, or within outdoor structures (vaults, etc.): Type 316 stainless steel (SS).
2. Within chemical areas: Vinyl ester fiberglass reinforced plastic (FRP) for pipe size up to 2 inch, epoxy coated steel for 2-1/2 inches size and larger.
3. Other locations: steel with galvanizing where noted, or if not otherwise noted, coating as required in Division 09 Finished Painting.
4. Additional requirements (including dielectric insulation): see following paragraphs.

B. For support of non-metallic pipe:
1. Submerged, buried, or within vaults: Type 316 stainless steel or FRP.
2. Within chemical areas: vinyl ester FRP.
3. Other locations: steel with galvanizing where noted, or if not otherwise noted, coating as required in Division 09 Finished Painting; all with local stress protection shields.
4. Additional requirements (including stress protection shields): see following paragraphs

C. Wherever stainless steel is noted, it shall be Type 316 unless noted otherwise.

2.4 INSULATION

A. See Drawings.

B. See also Section 220719.

2.5 SUPPORT AND RESTRAINT SYSTEMS

A. Steel or Ductile Iron Piping
1. Cast iron and ductile iron, steel, and stainless steel piping shall be supported at a maximum support spacing of 10 feet with a minimum of one support per pipe section at the joints.
2. Support spacing for ductile iron, steel, and stainless steel piping 2-in and smaller diameter shall not exceed 5 feet.

B. Copper Piping
1. Supports for copper pipe shall be copper plated or shall have a 1/16 inch plastic coating.
2. Support spacing for copper piping and tubing 2 inch and smaller diameter shall not exceed 5 feet and greater than 2 inch diameter shall not exceed 8 feet.

3. Where pipe supports come in contact with copper piping, provide protection from galvanic corrosion by: wrapping pipe with 1/16 inch thick neoprene sheet material and galvanized protection shield; isolators similar to Cooper B-Line B3195CT; or copper-plated or PVC-coated hangers and supports.

C. Non-Metallic Piping
1. All uninsulated non-metallic piping such as PVC, CPVC, HDPE, PVDF, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by non-metallic protection shields or other method as approved by the Engineer.
   a. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360-degree arc support is required, such as U-bolts, protection shields shall be provided for the entire pipe circumference. All U-bolts or clamps for non-metallic pipes shall be plastic coated.
   b. Protection shields shall have an 18-gauge minimum thickness, not be less than 12 inches in length and be securely fastened to pipe with Type 316 stainless steel straps not less than 1/2 inch wide.
2. Individually supported PVC pipes shall be supported as recommended by the pipe manufacturer except that support-spacing shall be manufacturers recommendation minus 2-ft. down to 5 ft spacing recommendation, then spacing shall be 3 feet.
3. Supports for horizontal multiple PVC plastic piping:
   a. Shall be continuous wherever possible.
   b. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as: Husky Ladder Flange Out by MPHusky; or equal.
   c. Rung spacing shall be 12 inches. Tray width shall be approximately 6 inch for single runs and 12 inches for double runs.
   d. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners similar to: Globe, Series 600; Unistrut Pipe/Conduit Clamps and Hangers; or equal.
   e. Spacing between clamps shall not exceed 9 feet. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

D. Framing Support System
1. See Part 2 MATERIALS for materials of construction.
2. Beams: Size such that beam stress does not exceed 25000 psi and maximum deflection does not exceed 1/240 of span.
3. Column Members: Size in accordance with manufacturer's recommended method.
4. Support Loads: Calculate using weight of pipes filled with water.
5. Maximum Spans:
   a. Steel and ductile iron pipe, 3 inch diameter and larger: 10 feet centers, unless otherwise shown.
   b. Other pipelines and special situations: Same as noted in previous paragraphs. Supplementary hangers and supports may be required.

E. All vertical pipes shall be supported at each floor or at intervals of not more than 12 feet by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to ensure rigid construction. All vertical pipes passing through pipe sleeves shall be secured using a pipe collar.

2.6 ANCHOR BOLTS/SYSTEMS

A. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear, and pullout loads imposed by loading and spacing on each particular support. DO NOTE USE ADHESIVE ANCHOR BOLTS ON ANY PIPE SUPPORT HUNG FROM A ROOF OR CEILING, unless specifically noted otherwise.

B. All post-installed anchors in concrete shall have current published ICC-ES Evaluation Report indicating the anchor is approved for installation in cracked concrete.

C. The latest edition of the following specification and recommended practices shall become part of this specification as if written herein. Wherever requirements conflict, the more stringent shall govern.
   1. ACI 318, Appendix D.
   2. ACI 355.2, Mechanical Anchors “Qualification of Post-Installed Mechanical Anchors in Concrete”
   3. Anchor manufacturer’s published installation requirements.

D. Expansion anchors:
   1. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1 inch behind the steel reinforcement.
   2. Manufacturers:
      a. Power-Stud+ SD4 and Power-Stud+ SD6 by Powers Fasteners, Brewster, NY,
      b. Kwik Bolt as manufactured by Hilti USA, Tulsa, Oklahoma; or
      c. Wej-it by Wej-it Expansion Products, Inc., Broomfield, Colorado.

E. Unless otherwise noted: use Type 304 stainless steel anchoring parts/bolts and hardware for non-submerged supports, Type 316 stainless steel for submerged anchors.

F. Size of anchor bolts as designed by manufacturer, 1/2 inch minimum diameter, or as shown on the Drawings.

G. Anchors to concrete in chemical areas shall be epoxy secured vinyl ester FRP all thread, insertion depth and size as required by the manufacturer for the design loads. Nuts, bolts and hardware shall all be vinyl ester FRP construction.

2.7 HANGER RODS

A. Where use of steel is allowed, hanger rods shall be hot-rolled steel, machine-threaded, and, except for stainless steel, galvanized after fabrication. The strength of the rod shall be based on its root diameter.
   1. Hanger rods shall be attached to concrete structures using single or continuous concrete inserts by the named support manufacturers above. Where use of steel is allowed, inserts shall be malleable iron or steel with galvanized finish.

2. Beam-clamps, C-clamps, or welded-beam attachments shall be used for attaching hanger rods to structural steel members.

B. Minimum rod size for metallic rod hangers: (* For pipe diameters less than 14 inch, if using pipe roller, use 2 hanger rods with minimum diameter noted below for pipe's diameter).

	Nominal Pipe / Tube Diameter	Minimum Hanger Rod Diameter
1	Less than 2-1/2 inch	1/4 inch*
2	3 to 8 inches	1/2 inch
3	10 to 14 inches	3/4 inch*
4	16 to 20 inches	2 at 1 inch
5	24 inches	2 at 1-1/4 inch
6	30 inches	2 at 1-1/2 inch

2.8 SINGLE PIPE HANGERS

A. Unless otherwise indicated, pipe hangers and supports shall be standard catalogued components, conforming to the requirements of MSS-41, 58, or 69 and shall be of the following type:
1. Anvil International
2. Equal models by: Carpenter & Patterson, Inc., Wobum, MA; Cooper B-Line; Gulf State Manufacturing; or Unistrut Northeast, Cambridge, Massachusetts.

B. Single pipes shall be supported by hangers suspended by hanger rods from structural steel members, concrete ceilings, bottom of trapeze hangers, and wall-mounted steel angle brackets.

C. Where pipes are near walls, beams, columns, etc., and located an excessive distance from ceilings or underside of beams, welded steel wall brackets similar to Carpenter and Patterson, Figure Nos. 68, 79, 84, or 139 shall be used for hanging pipe. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.

2.9 MULTIPLE PIPE HANGERS

A. Suspended multiple pipes, running parallel in the same horizontal plane that are adjacent to each other, shall be suspended by trapeze type hangers or wall brackets. Where use of steel is allowed, trapeze hangers shall consist of galvanized structural steel channel supported from galvanized threaded rod or attached to concrete walls, columns, or structural steel support members. See previous paragraphs about multiple PVC pipe supports.

B. Except as otherwise specified herein, pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs similar to:
1. Anvil Fig. 175
2. Cooper B-Line B3147A or B3147B.

3. Where use of steel is allowed, material of construction shall be galvanized steel. Chair U bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

2.10 SINGLE PIPE SUPPORTS FROM BELOW

A. Single pipes located in a horizontal plane close to the floor shall be Pedestal type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
   1. Nonadjustable Saddle: MSS SP 58, Type 37 with U-Bolt
      a. Anvil, Figure 259.
      b. Cooper B-Line, Figure B3090.
   2. Adjustable Saddle: MSS SP 58, Type 38 without clamp
      a. Anvil, Figure 264.
      b. Cooper B-Line, Figure B3093.

B. Pipes less than 3 inch in diameter
   1. Hold in position by supports fabricated from steel C channel, welded post base similar to Unistrut, Figure P2072A, where use of steel is allowed; and pipe clamps similar to Unistrut, Figures P1109 through 26.
   2. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected by horizontal member of sufficient load capacity to support pipe.
   3. Fasten supports to nearby walls or other structural member to provide horizontal rigidity.
   4. More than one pipe may be supported from a common fabricated support.

C. Pipes 3 inch in diameter and larger
   1. Support by adjustable stanchions.
   2. Provide at least 4 inch adjustment
   3. Flange mount to floor.

D. Use yoked saddles for piping whose centerline elevation is 18 inch or greater above the floor and for all exterior installations.

E. Pipe roller type supports shall be used where required to accommodate thermal movement in conjunction with axial supports.

2.11 WALL SUPPORTED SINGLE AND MULTIPLE PIPES

A. Single or multiple pipes located adjacent to walls, columns, or other structural members shall be supported using welded steel wall brackets, where use of steel is allowed, as manufactured by Carpenter and Patterson, Figure No. 69, 84, or 139.

B. Where noted, multiple pipes may be supported on C-channel with steel brackets similar to Unistrut pipe clamps; with pipe anchor chairs; or equal.

C. Individual pipes, up to 8-in diameter, where noted, may use MSS Type 8 pipe clamps as noted on the Drawings.

D. Securely fasten all members to wall, column, etc., using double-expansion shields or other method as approved by the Engineer. Provide additional wall bearing plates as required.

2.12 BASE ANCHOR SUPPORT

A. Bend Support: Where pipes change direction from horizontal to vertical via a bend, install a welded or cast base bend support to carry the load. Fasten to the floor, pipe stanchion, or concrete pedestal using expansion anchors or other method as approved by the Engineer.

B. Concrete Supports: Where indicated, securely fasten pipe bends to concrete supports with suitable metal bands as required and approved by the Engineer. Isolate piping from poured concrete with a neoprene insert.

2.13 VERTICAL PIPE SUPPORTS

A. Where vertical pipes are not supported by a Unistrut type system as specified, they shall be supported in one of the following methods.
   1. For pipes 1/4 to 2 inch in diameter,
      a. Provide extension hanger ring with an extension rod and hanger flange.
      b. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported.
      c. Where use of steel is allowed, the hanger ring shall be steel- or PVC-clad depending on the supported pipe material of construction. The hanger ring shall be equal to Carpenter & Patterson, Figure Nos. 81.
      d. Where use of steel is allowed, the anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson, Figure No. 85.
   2. For pipes equal to or greater than 2 inch in diameter,
      a. extended pipe clamps similar to Carpenter & Patterson, Figure No. 267 may be used.
      b. Attach hanger to concrete structures using double expansion shields,
      c. Attach hanger to metal support members using welding lugs similar to Carpenter & Patterson, Figure No. 114.

B. Pipe supports shall be provided for closely spaced vertical piping systems required to provide a rigid installation. The interval of vertical support spacing shall be as specified, but in no case shall vertical interval exceed 12 feet. The support system shall consist of a framework suitably anchored to floors, ceilings, or roofs.

C. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12 feet shall be supported by base elbows/tees, clamps, brackets, wall rests, and pipe collars, all located as required to ensure a rigid installation.

D. Pipe riser clamps, per MSS SP58, shall be used to support all vertical pipes extending through floor slabs. Where use of steel is allowed, riser clamps shall be galvanized steel manufactured by:
   1. Carpenter & Patterson, Figure No. 128.
   2. Anvil, Figure 261.
   3. Cooper B-Line, Figure B3373.
   4. Or equal.

E. Copper-clad or PVC-coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps. Insulation shall not be damaged by clamp installation.

2.14 SPECIAL SUPPORTS

A. Frame work supports
   1. Vertical and horizontal supporting members shall be U-shaped channels similar to Unistrut, Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps. See pipe clamp and strap requirements.
   2. For piping 3 inch and smaller, framework shall be as manufactured by:
      a. the Unistrut Corporation;
      b. Power-Strut (or Ackinstrut where fiberglass systems are specified);
      c. Multi-Strut by Carpenter-Paterson
      d. or equal.
   3. For piping larger than 3 inch, the support frame shall be fabricated from structural stainless steel or steel shapes, depending upon the support location, and secured through the use of drop in, adhesive or expansion anchors.
   4. The assemblies shall be furnished complete with all nuts, bolts, and fittings required for a complete assembly including end caps for all Unistrut members.
   5. Electrical Conduit Support: Under Division 26.
   6. The design of each individual framing system shall be the responsibility of the Contractor. Submit shop drawings, and show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached. See also Article SUPPORT AND RESTRAINT.

B. Supports not otherwise described in this Section shall be fabricated or constructed from standard structural stainless steel or steel shapes in accordance with applicable provisions of Section 055000 “Metal Fabrications,” or Unistrut-type frame; have anchor hardware similar to items previously specified herein; shall meet the minimum requirements listed below; and be subject to the approval of the Engineer.

C. Additional Pipe Support Situations
   1. Supporting Multiple Chemical and Related Piping:
      a. Location: indicated on Drawings or otherwise required, especially adjacent to chemical pumps.
      b. Use: framework support.
      c. Materials: FRP, with proper local stress protection.

2.15 SHOP FACTORY FINISHING

A. Prepare and prime metallic (except stainless steel) supports in accordance with Division 09.

2.16 ACCESSORIES

A. Insulation Shield: Install on insulated non-steel piping. Oversize the rollers and supports, as required.

1. Manufacturers:
   a. Anvil, Figure 167;
   b. Cooper B-Line, Series B3151.

B. Welding Insulation Saddle: Install on insulated metal pipe. Oversize the rollers and supports, as required.
1. Manufacturers:
   a. Anvil, Figure 160;
   b. Cooper B-Line, Series B3160

C. Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
1. Isolation pads to be neoprene, waffle type.
2. Manufacturers:
   a. Mason Industries, Type W;
   b. Korfund.

D. Dielectric Barrier
1. Install between carbon steel members and copper or stainless steel pipe.
2. Install between stainless steel supports and non-stainless steel ferrous metal piping.
3. All stainless steel piping shall be isolated from all ferrous materials, including galvanized steel by use of neoprene sheet material and protection shields.

E. Electrical Isolation: Install 1/4 by 3 inch neoprene rubber wrap between submerged metal pipe and oversized clamps.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 013100 - Project Management and Coordination: Requirements for installation examination.

B. Verify field dimensions as indicated on the Drawings.

3.2 INSTALLATION

A. Obtain permission from Engineer before using powder-actuated anchors.

B. Obtain permission from Engineer before drilling or cutting structural members.

C. Inserts:

1. Install inserts for placement in concrete forms. Before setting inserts, all drawings and figures shall be checked that have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.
2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4-inch and larger.
4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

D. Pipe Hangers and Supports:

1. Install according to: ASME B31.3 ASME 31.9 and MSS SP 58.
2. Support horizontal piping as indicated on Drawings, depending upon pipe size.
3. Install hangers with minimum 1/2 in space between finished covering and adjacent Work.
4. Place hangers within 12 in of each horizontal elbow.
5. Use hangers with 1-1/2 in minimum vertical adjustment.
6. Support horizontal cast iron pipe adjacent to each hub, with 5 ft maximum spacing between hangers.
7. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
8. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
9. Support riser piping independently of connected horizontal piping.
10. Provide copper-plated hangers and supports for copper piping.
11. Design hangers for pipe movement without disengagement of supported pipe.
12. Support piping independently so that equipment is not stressed by piping weight or expansion in piping system.
13. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
14. Provide welded steel brackets where piping is to be run adjacent to building walls or columns.
15. Use beam clamps where piping is to be suspended from building steel.
16. Insulated Piping: Provide two bolted clamps designed to accommodate insulated piping.
17. Use offset clamps where pipes are indicated as offset from wall surfaces.
18. Proceed with installation of piping and supports only after any building structural work has been completed and new concrete has reached its 28-day compressive strength.
19. The installation of pipe support systems shall not interfere with the operation of any overhead bridge cranes, monorails, access hatches, etc. No piping shall be supported from stairs, other pipes, ladders, and walkways unless authorized by the Engineer.
20. Repair mounting surfaces to original condition after attachments are made.
21. Brace horizontal pipe movements by both longitudinal and lateral sway bracing.
22. Where supports are required in areas to receive chemical resistant seamless flooring, install supports prior to application of flooring system.

E. Insulation:

1. Provide clearance in hangers and from structure and other equipment for installation of insulation.
2. Conform to Section 220719 - Plumbing Insulation.

F. Equipment Bases and Supports:

1. Provide equipment pads of concrete, minimum 3-1/2 in thick and extending 6 in beyond supported equipment. Comply with Section 033000 - Cast-in-Place Concrete.

G. Prime Coat:

1. Prime coat exposed steel hangers and supports.
2. Conform to Section 099100 - Painting and Coating.
3. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.3 FIELD QUALITY CONTROL

A. All pipe support systems shall be tested after installation in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired, augmented or replaced to the satisfaction of the Engineer.

B. After the work is installed, but before it is filled for start-up and testing, the Support System Design Engineer shall inspect the work and shall certify its complete adequacy. Each system shall be inspected and certified in the same way.

C. Submit a report, including all field modifications and including all certificates.
1. Insert state where project is located
2. The report shall bear the stamp of a professional engineer registered in Michigan and shall be subject to the review of the Engineer.

3.4 ATTACHMENT SCHEDULE

A. Pipe Hanger Spacing:
1. Pipe Material: Copper tube.
   a. Size: 1-1/4 inches (32 mm) and smaller.
   b. Maximum Hanger Spacing: 6 feet (1.8 m).
   c. Hanger Rod Diameter:1/2 inch (13 mm).
2. Pipe Material: Copper tube.
   a. Size: 1-1/2 inches (39 mm) and larger.
   b. Maximum Hanger Spacing: 10 feet (3.0 m).
   c. Hanger Rod Diameter:1/2 inch (13 mm).
3. Pipe Material: Polypropylene.
   a. Maximum Hanger Spacing: 4 feet (1.2 m).
   b. Hanger Rod Diameter:3/8 inch (9 mm).
4. Pipe Material: PVC.
   a. Maximum Hanger Spacing: 4 feet (1.2 m).
   b. Hanger Rod Diameter:3/8 inch (9 mm).
5. Pipe Material: Steel.
   a. Size: 3 inches (75 mm) and smaller.
   b. Maximum Hanger Spacing: 12 feet (3.7 m).
   c. Hanger Rod Diameter:1/2 inch (13 mm).
6. Pipe Material: Steel.
   a. Size: 4 inches (100 mm) and larger.
   b. Maximum Hanger Spacing: 12 feet (3.7 m).
   c. Hanger Rod Diameter:5/8 inch (15 mm).

END OF SECTION 400507

SECTION 400524 - STEEL PROCESS PIPE

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. Steel pipe.
   2. Fittings.
   3. Accessories.

B. Related Requirements:
   1. Section 099100 - Painting: Finishes as specified by this Section.
   2. Section 400506 - Couplings, Adapters, and Specials for Process Piping: Pipe penetrations, restrained joints, flexible connections, expansion joints and loops, and sleeve-type couplings.
   3. Section 400507 - Hangers and Supports for Process Piping: Hangers, anchors, sleeves, and sealing of piping to adjacent structures.
   4. Section 400551 - Common Requirements for Process Valves: Common product requirements for valves for placement by this Section.

1.3 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information regarding pipe and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, and material lists, locations of all expansion joints, supports, anchors, harnessing, valves, etc.

D. Complete schedule of all components included in the pipeline drawings, indicating the materials and schedule number of thickness of all pipe, the materials and class of all fittings and valves.

E. Details of pipe coating, wrapping, lining, and painting.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Welder Certificates: Submit welders' certification of compliance with AWS D1.1/D1.1M, verifying qualification within previous 12 months.

H. Delegated Design Submittals: Submit signed and sealed Shop Drawings with piping layout and with design calculations and assumptions for pipe sizing methods.

I. Source Quality-Control Submittals: Indicate results of factory tests and inspections and provide required certifications including certified materials test reports indicating physical and mechanical properties and heat treatment for all piping components.

J. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

K. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

L. American Iron and Steel (AIS): Submit certification indicating compliance with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

B. Materials in Contact with Potable Water: Certified according to NSF 61 and NSF 372.

C. Perform Work according to City of Flint Department of Public Works standards.

D. Maintain copy of each standard affecting Work of this Section on Site.

E. Roll or permanently inscribe the manufacturer's name or trademark, the year of manufacture and the ASTM or API specification number on the pipe surface at the manufacturer's plant. Alternately, stencil the manufacturer's name or trade mark, year of manufacture and ASTM or API specification number on the pipe surface. Pipe 1-1/2 inches and less in nominal diameter shall be bundled and tagged.

F. Utilize only certified welders, having current certificates conforming to the requirements of the ASME code to perform all welding on steel pipes. Welders to be qualified under the requirements of Section IX Welding Qualifications, of the ASME Boiler and Pressure Vessel Code.

G. The Engineer reserves the right to perform shop inspections of the manufacture of the pipe. Provide at least 30 days' notice to the Engineer prior to the beginning of any work so that inspection may be arranged. Furnish all facilities required for the inspection of materials and workmanship in the shop.
   1. Inspection may include, welding inspection, review of certified material test reports, traceability check, and witness of assembly and fit-up. Prior to manufacture, the pipe fabricator shall supply the following information on suppliers of plate, piping, and other components: Items(s) furnished, company name and address, contact name, telephone and fax number. The Engineer reserves the right to visit any or all of the suppliers and conduct inspections at their facilities.
   2. The inspector has the authority to reject any material or work that does not meet the requirements of the Contract Documents.
   3. Inspection at the shop is intended as a means of facilitating the work and avoiding errors. Shop inspection does not relieve the Contractor from the responsibility for furnishing proper materials or workmanship.
   4. The costs of all welding supervision and inspections and tests will be borne by the Contractor. The Contractor will engage inspectors to inspect welded connections and to perform tests and prepare test reports. Perform non-destructive testing as required by the specification under which the pipe is manufactured.
   5. Correct or reweld and retest deficient welds at the Contractor's expense and to the satisfaction of the Engineer and/or an acceptable independent testing lab.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum five years' documented experience.

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect piping and appurtenances by storing off ground.
3. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum Conditions: Do not store or handle uninstalled lined pipes or fittings at temperatures below zero degrees F.

1.11 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.12 SYSTEM DESCRIPTION

A. Steel piping shall be installed in the locations shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of steel pipe and fittings for use in transporting water, wastewater, residuals, air, and chemical solutions.

C. Steel piping system listed below shall be designed for the following conditions:
1. System: Sodium Hydroxide Feed System between bulk and day tank
   a. Fluid: 25 to 50% strength Sodium Hydroxide Solution
   b. pH: 14
   c. Specific Gravity: 1.53
   d. Pressure: Normal – 15 psi/ Test – 25psi
   e. Temperature: 60 to 110 degrees F
   f. Lining: None
   g. Special Conditions: None

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. General Service Piping (up through 24-inch diameter):
1. Comply with ASTM A53/A53M; Grade A and B.
2. Type: Seamless.
3. Schedule: 80.
4. Finish: Hot-dip galvanized.

B. Joints:
1. Description: Butt welded] Flanged.
2. Joints for steel pipe two inches diameter and less will be screwed joints with clean cut threads conforming to the American Standard for Pipe Threads, as specified below. Screwed joints to be made up with good quality thread compound, suitable for the intended service, applied to the make thread only.
3. Joints for steel piping larger than two-inch diameter will be butt, socket or slip-on welded flanges.

C. Fittings:
1. Type:
   a. Piping 2 Inches and Smaller: Threaded.
   b. Piping 2-1/2 Inches and Larger: Welded or flanged.
2. Dimensions: Comply with ASME B36.10M.
3. Flanged Connections: As required to connect steel piping to fittings and equipment.
4. Threaded Fittings:
   a. Class: 150.
   b. Malleable Iron:
      1) Comply with ASTM A47/A47M and ASME B16.3.
      2) Type: Black; banded.
5. Rigid Steel Couplings: Comply with ASTM A865/A865M.
6. Butt-Welding Fittings:
   a. Comply with ASTM A105/A105M and ASME B16.9.
   b. Class: 150.
   c. Where welding fittings are approved for assembly in cement lined pipelines, fittings to be provided with a plain end, grooved end or shouldered end section welded on each end of the fitting and assembled with sleeve-type, groove type, or shoulder-end couplings as required. Long tangent welding fittings may be substituted for welded-on spool piece fittings provided they can accommodate the flexible pipe couplings.
7. Socket-Welding Fittings (applies to pipe 3-inch diameter and smaller):
   a. Comply with ASTM A105/A105M, Grade 2 ASTM A858/A858M and ASME B16.11.
   b. Class: 150.
   c. Fittings rated at 2000 pounds minimum.
   d. Socket welding fittings welded in conformance with the applicable provisions of the Code for Pressure Piping, ASME B31.1.
8. Flanged Fittings:
   a. Forged Steel: Comply with ASTM A105/A105M, and ASME B16.5.
   b. Class: 150.

c. Steel flanged fittings to utilize forged steel slip-on flanges. Fittings will be Class 125 and Class 250 fittings conforming to the requirements of ASME B16.5, 150-pound or 300-pound, respectively as specified, except flanges that are flat faced. Provide Class 125 fittings conforming to AWWA C207, Class B.
d. Cast steel flanged fittings to be assembled with forged steel flanges of the same pressure rating, conforming to ASME B16.5.
e. Facing and Drilling:
   1) Comply with ASME B16.5.
   2) Type: **-inch raised face**.
f. Backing Flanges:
   1) Material: Cast steel.
   2) Comply with ASTM A216/A216M; Grade WCA.
   3) Class: 150.
   4) Type: Van stone.
   5) Drilling: Comply with ASME B16.5.
g. Fasteners:
   1) Bolts: Comply with ASTM A193/A193M; Grade; B7, hex head.
   2) Nuts: Comply with ASTM A194/A194M; Grade B7; hex head.
   3) Cast-Iron Mating Flange on Valves or Equipment:
      a) Bolts: Comply with ASTM A193/A193M, Grade B7; hex head.
      b) Nuts: Comply with ASTM A194/A194M; Grade B7; hex head.
   4) Washers: Constructed of same material as bolts.

9. Mechanical Couplings: Comply with ASTM F1476.
10. Unions:
    a. Piping 2 Inches and Smaller: Threaded.
    b. Piping 2-1/2 Inches and Larger: Threaded or flanged.
11. Flange gaskets shall be PTFE gaskets.

2.2 FINISHES

A. Coat machined faces of flanges with temporary rust-inhibitive coating.

B. Prepare piping for field finishes as specified in Section 099100 - Painting.

2.3 ACCESSORIES

A. Pipe-Thread Tape:
   1. Material: PTFE.
   2. Comply with ASTM D3308.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution”: Requirements for installation examination.

B. Verify that field dimensions are as indicated on the Drawings.

C. Inspect existing flanges for nonstandard bolt-hole configurations or design and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 017300 “Execution”: Requirements for installation preparation.

B. Ream ends of threaded pipes and file smooth.

C. Thoroughly clean pipe and fittings before installation.

D. Surface Preparation:
   1. Touch up shop-primed surfaces with primer as specified in Section 099100 - Painting.
   2. Solvent-clean surfaces that are not shop primed.
   3. Clean surfaces to remove loose rust, mill scale, and other foreign substances by power wire brushing or commercial sand blasting; SSPC-SP 6.
   4. Prime surfaces as specified in Section 099100 - Painting.

3.3 INSTALLATION

A. According to ASME B31.3.

B. Run piping straight along alignment as indicated on the Drawings, with minimum number of joints.

C. Fittings:
   1. Clean gasket seats thoroughly and wipe gaskets clean prior to installation.
   2. Install fittings according to manufacturer instructions.
   3. Bolts:
      a. Determine torque per AWWA M11.
      b. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight.
      c. Use torque wrench to tighten bolts to manufacturer instructions.
      d. Project 1/4-inch beyond the nut when joint with gasket is assembled.

D. Install cement-lined fabricated fittings with flexible pipe couplings.

E. Provide required upstream and downstream clearances from devices as indicated on Drawings.

F. Install piping with sufficient slopes for venting or draining liquids and condensate to low points.

G. Support exposed piping as specified in Section 400507 - Hangers and Supports for Process Piping. Where temporary supports are used during construction, provide sufficient strength and rigidity to prevent shifting or distortion of the pipe.

H. Provide expansion joints as specified in Section 400506 - Couplings, Adapters, and Specials for Process Piping, and provide pipe guides as specified in Section 400507 - Hangers and Supports for Process Piping, to compensate for pipe expansion due to temperature differences.

I. Dielectric Fittings: Provide between dissimilar metals.

J. Finish primed surfaces as specified in Section 099100 - Painting.

K. When required, cut pipe by machine in a neat workmanlike manner without damage to the pipe. Cut ends to be smooth and at right angle to the axis of the pipe. Clean all steel pipe thoroughly before installation including smoothing and cleaning interior and exterior cut ends. All uncoated pipes to be placed on end and hammered to remove scale and loose particles. Repair lining damage to the satisfaction of the Engineer before the pipe is installed.

L. Welding of steel butt-welding fittings, steel fabricated fitting and steel pipe to be in strict conformity with the Code for Pressure Piping, ASME B31.1, Section 6 and its Supplements. Submit Certificates of qualifications of current issue, conforming to the requirements of the Code to the Engineer before proceeding with any pipe welding. Use backing rings of carbon steel with spacer nubs that strike-off or melt with the weld for all pipe welding butt joints unless otherwise specified.

M. Perform field welding of cement mortar lined steel pipe only where approved and in accordance with AWWA C206. Use flanged or other approved joints not approved for field welding.
   1. Machine cut the ends of the lined pipe for pipe-to-pipe joints to provide an approximate bevel of 27-1/2 degrees. Ends may be chipped provided there is no damage to the cement lining, cleaned of scale, rust, oil and other foreign matter. Where fittings already having a bevel of 37-1/2 degrees are to be welded to pipe, pipe ends to be beveled to a 17-1/2 degree angle, making a total angle of bevel between joints of approximately 55 degrees. A 1/8-inch land to be provided where possible.
   2. Pipe ends to be joined will be approximately 1/32 inch apart before tacking. Backing rings will not be used at welded joints in cement mortar lined pipe. Small tack welds to be made using a 1/8-inch electrode. The first bead or layer of welding laid by bridging across from bevel to bevel at the bottom of the groove just at the top of the land. A suitable crown reinforcement layer to be made on the top of the joint to finish off.
   3. Direct current (DC) will be used for welding, with the base material on the negative side.
   4. The first pass will be a stringer bead using a 1/8-inch electrode with a current of 80 to 90 amperes at 50 to 55 Volts. The second and succeeding passes to be woven beads using a 1/8-inch electrode and a current of 90 to 100 amperes at 55 to 58 Volts. All passes to be made slowly and with care not to burn through the land or the shoulder into the lining of the pipe. The joint will not be hotter than 100 deg. F. For large size pipe, a 5/32-inch electrode may be used, provided the temperature of the joint is held within 100 deg. F.
   5. No stress relieving of welded joints is necessary unless the pipe wall thickness warrants it. After the weld is completed, the joints in the lining will be filled with a special compound of a wet slurry mix of the same cement used for the lining. Where accessible from the end of the pipe, the welded joint is to be swabbed with cement using a paint brush thoroughly wetted with the cement slurry.
   6. Defects causing leaks in welded joints will be repaired by welding without damaging the cement lining using procedures similar to that specified hereinbefore.

N. Finished welds to be examined as required by AWWA C206.

3.4 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Circumferential deflection of all pipe in-place: not to exceed 2.0 percent of the pipe diameter.

C. Install pipe within tolerance of 5/8 inch.

3.5 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Inspection:
   1. Inspect for damage to pipe lining or coating and for other defects that may be detrimental as determined by Engineer.
   2. Repair damaged piping or provide new, undamaged pipe.
   3. After installation, inspect for proper supports and interferences.

C. Pressure Testing:
   1. Test Pressure: Not less than 200 psig or 50 psi in excess of maximum static pressure, whichever is greater; 150 percent of maximum operating design pressure.
   2. Conduct hydrostatic test for minimum two hours.
   3. Filling:
      a. Slowly fill with water section to be tested and expel air from piping at high points.
      b. Install corporation cocks at high points.
      c. Close air vents and corporation cocks after air is expelled.
      d. Raise pressure to specified test pressure.
   4. Observe joints, fittings, and valves under test.
   5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
   6. Leakage:
      a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
      b. Maintain pressure within plus or minus 5 psi of test pressure.
      c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
      d. Compute maximum allowable leakage by following formula:
         1) L = SD x sqrt(P)/C.
         2) L = testing allowance in gph.
         3) S = length of pipe tested in feet.
         4) D = nominal diameter of pipe in inches.
         5) P = average test pressure during hydrostatic test in psig.
         6) C = 148,000.
         7) When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.
      e. If test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections, and retest until leakage is within allowable limits.
      f. Correct visible leaks regardless of quantity of leakage.

3.6 CLEANING

A. Sections 017300 - Execution and 017700 - Closeout Procedures: Requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. After installation, clean pipe interior of soil, grit, loose mortar, and other debris.

END OF SECTION 400524

SECTION 400531 - THERMOPLASTIC PROCESS PIPE

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. PVC pipe.
2. PVC tube.
3. Double Containment pipe
4. Double Containment low point leak detection
5. Fittings.
6. Accessories for plastic piping.

B. Related Requirements:

1. Section 331116 - Site Water Utility Distribution Piping: Pipe laying requirements and tolerances, excavation, backfill, and thrust restraints.
2. Section 400506 - Couplings, Adapters, and Specials for Process Piping: Pipe penetrations, restrained joints, flexible connections, expansion joints and loops, and sleeve-type couplings.
3. Section 400507 - Hangers and Supports for Process Piping: Hangers, anchors, sleeves, and sealing of piping to adjacent structures.
4. Section 400551 - Common Requirements for Process Valves: Common product requirements for valves for placement by this Section.

1.3 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with piping and equipment connections specified in other Sections and indicated on Drawings.

1.4 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum two weeks prior to commencing Work of this Section.

1.5 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog information regarding pipe and fittings.

C. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, sizes, materials lists, location of all fittings, valves, and in-line accessories.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer’s recommended butt fusion welding procedures identifying all quality control checks during the fusion procedure including the minimum and maximum allowable bead formation during the heat soak process and the final weld roll back process for the various size pipes.

F. Manufacturer to provide a sample joint for each size pipe to be supplied that is 12-in long and has two heat fusion welds that identifies the manufacturer’s minimum and maximum allowable bead thicknesses. Provide documentation that the sample was pressure tested to 150 psi or the specified pressure.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for pipe sizes and sizing methods.

H. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

I. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

J. Qualifications Statements:
   1. Submit qualifications for manufacturer, installer, and licensed professional.
   2. Submit manufacturer's approval of installer.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping, valves and other appurtenances, connections, and centerline elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.7 QUALITY ASSURANCE

A. Permanently mark each length of pipe with manufacturer's name or trademark and indicate conformance to standards.

B. Materials in Contact with Potable Water: Certified according to NSF 61.

C. Perform Work according to the best practices and methods and shall be suitable for the intended service.

D. Maintain copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture each of the respective thermoplastic pipe systems.

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection:
1. Accept materials on Site in manufacturer's original packaging and inspect for damage.
2. Manufacturer's Packaging: Comply with ASTM D3892.

C. Storage: Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from puncture, abrasion, moisture, dust, and UV by storing in clean, dry location remote from construction operations areas.
2. Protect piping and appurtenances by storing off ground.
3. Provide additional protection according to manufacturer instructions.

1.10 AMBIENT CONDITIONS

A. Section 015000 - Temporary Facilities and Controls: Requirements for ambient condition control facilities for product storage and installation.

B. Minimum and Maximum Temperatures: Do not install pipe when temperature is below 40 degrees F or above 90 degrees F if pipe is exposed to direct sunlight.

C. UV Protection: Provide pipe installed above ground or outside with UV protection.

1.11 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.12 DOUBLE CONTAINMENT SYSTEM DESCRIPTION

A. Double containment piping systems shall be installed in those locations as shown on the Drawings. Double containment piping systems are designated on the Drawings. Drawings show only a generic layout. The system supplier shall be responsible for furnishing a detailed layout of the double containment piping showing the support locations, expansion/contraction, containment thrust blocking, termination points (at start and end of containment piping), leak detection sensors (and/or, visual inspection wells), drains and valve boxes.

B. Double containment piping systems are required at the underground, buried chemical piping as shown on the Drawings.

C. The underground system shall be designed to handle several different types of chemicals conveyed belowground as noted on the Drawings. The double containment piping shall be designed to be compatible with the following chemicals:

Chemical	**Concentration (mg/L)**
Caustic Soda (CS)	25 to 50%
Corrosion Inhibitor	100%/as-delivered
Sodium Hypochlorite (SHC)	10 to 15%

D. MSDS sheets of the chemicals shall be requested from the Engineer by the successful Bidder.

E. The piping system shall be designed to handle a fluid temperature of 40° to 110°F, and an outside air temperature of 20°F to 110°F.

F. The carrier and containment pipe and fittings shall be Schedule 80 PVC Pipe unless otherwise a different material is recommended by manufacturer due to chemical compatibility issues.

G. The equipment and materials specified herein are intended to be standard types of plastic pipe, fittings, valves and appurtenances for use in transporting chemicals.

H. If shown on the Drawings, provide a leak detection control panel shall be provided by the Double Containment Pipe System Supplier. Control System to operate on 120 VAC. Subcontractor to coordinate with double containment pipe system supplier how many zones and control panels will be required for these systems.

I. If no automatic leak detection system and control panel is indicated Manufacturer shall provide visual inspection leak detection wells for each chemical feed system at each low point. Manufacturer shall design system and subcontractor shall coordinate installation around visual leak detector wells to protect from damage and operator access.

J. Double containment piping systems shall be installed in those locations as shown on the Drawings. Piping will not be installed until all materials compatibility of the proposed piping with the intended chemical service has been proven by the manufacturers and certified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE DOUBLE CONTAINMENT MANUFACTURERS–

A. The double containment chemical piping system shall be manufactured by Guardian a Division of IPEX, Spears, or Pro-Lock® PVC Double Containment piping systems by Asahi America, or Engineer approved equal.

2.2 PVC PIPE, TUBE, AND FITTINGS

A. PVC Pipe and Fittings:
   1. Pipe and Fittings:
      a. Comply with ASTM D1785, Class 12454.
      b. Schedule: 80.
      c. Fittings: ASTM D2467, Schedule 80, socket; ASTM D2464, Schedule 80 threaded.
   2. Joints: ASTM D2855, socket, solvent welded
   3. Flanges: Comply with ASME B16.5, rated for maximum 150 psig working pressure.

B. PVC Pipe and Fittings:
   1. Pipe:
      a. Comply with AWWA C900.
      b. DR 25, Class 165.
   2. Fittings:
      a. Material: Molded PVC.
      b. Type: Push-on, comply with AWWA C907.
      c. Gaskets: Comply with AWWA C111.
   3. Joints:
      a. Type: Compression gasket ring.
      b. Comply with ASTM D3139.
   4. Materials:
      a. Comply with ASTM D1784.
      b. Minimum Cell Classification: 12454-C.

C. PVC Tube and Fittings:
   1. Tube:
      a. Type: Clear.
      b. Size and Wall Thickness: As indicated on the piping drawings.
      c. Pressure Rating: As indicatedon Drawings.
   2. Fittings:
      a. Type: Compression.
      b. Materials: Suitable for application.
   3. Threads:
      a. Type: Straight.
      b. Comply with ASME B1.1.

D. PVC Double Containment Piping and Fittings
   1. All buried chemical piping, fittings, and valves shall be a prefabricated double containment piping system.

2. All of the double containment piping system shall consist of Schedule 80 PVC primary piping system supported within a Schedule 80 PVC secondary containment housing. The double containment piping installed above grade shall be treated to protect from UV degradation from sunlight.
3. Double containment chemical pipe system manufacturer shall design and provide a leak detection system.
4. Double containment fittings shall be prefabricated. Splitting and rewelding of fittings and 2-piece gasketed fittings will not be accepted.
5. Containment pipe size shall be based on the size of the primary carrier pipe as follows:

Carrier Pipe Diameter	Containment Pipe Diameter
½ inch	2 inches
¾ inch	3 inches
1 inch	3 inches

6. Interstitial supporting devices used to center and support the primary piping and fittings within the containment piping and fittings shall be manufacturer instructions and shall be installed prior to delivery of the pipe and fittings. The spacers shall be designed to permit the carrier and containment pipes to expand and contract without stress or wear on the pipes as well as provide for drainage and free air circulation. Spacing shall be as recommended by the manufacturer.

E. PVC Double Containment Low Point Leak Detection
1. Provide and install at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve with hose connection and or rise and sensor extension handle. Each sensor shall have LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket.
2. Control console shall not penetrate the containment piping jacket. Console shall have 10-zone capacity, alarm lamps, pilot lamp, reset buttons, test buttons and mute switch. Console shall also have a common audible alarm and external switched output for accessory alarms. Optional automatic battery backup and timers available. Manufactured by GUARDIAN SYSTEMS, ASAHI AMERICA, or equal.
3. Panel to be NEMA 4X SS and shall be equipped with audible and visual alarms with silence pushbutton.
4. Panel shall also have pushbutton test capability for each zone and each pipeline.

2.3 FINISHES

A. Coat machined faces of metallic flanges with temporary rust-inhibitive coating.

2.4 ACCESSORIES

A. PVC Piping:
1. Flange Bolting:
   a. Hex-Head Bolts: Stainless steel; ASTM F593 Grade 316.
   b. Hex-Head Nuts: Stainless steel; ASTM F594 Grade 316.
2. Flange Gaskets:
   a. Type: Full faced.

b. Material: EPDM.
c. Comply with ASME B16.21.

3. Push-On Joint Seals:
   a. Material: EPDM for sodium hydroxide and corrosion inhibitor and Viton®/FKM for sodium hypochlorite.
   b. Comply with ASTM F477.
4. Solvent Cement:
   a. Comply with ASTM D2564.
   b. Formulated for use with sodium hypochlorite and other caustic solutions.
   c. Primers: Comply with ASTM F656. manufactured by the solvent weld cement manufacturer.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed pipe sections and tubing.

C. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Requirements for installation examination.

B. Verify that field dimensions are as indicated on the Drawings.

C. Inspect existing flanges for nonstandard bolt hole configurations or design and verify that new pipe and flange mate properly.

3.2 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Ream pipe and tube ends, remove burrs, and bevel plain-end pipe.

C. Thoroughly clean pipe and fittings before installation.

D. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. Comply with ASME B31.3 and B31.9.

B. Run piping straight along alignment as indicated on Drawings, with minimum number of joints.

C. Fittings:
   1. According to manufacturer instructions.
   2. Gaskets:
      a. Clean seats thoroughly.
      b. Wipe gaskets clean prior to installation.
   3. Tighten bolts progressively, drawing up bolts on opposite sides until bolts are uniformly tight; use torque wrench to tighten bolts to manufacturer instructions.

D. Provide required upstream and downstream clearances from devices as indicated.

E. Install piping with sufficient slopes for venting or drainage of liquids and condensate to low points.

F. Support exposed piping as specified in Section 400507 - Hangers and Supports for Process Piping.

G. Provide expansion joints as specified in Section 400506 - Couplings, Adapters, and Specials for Process Piping, and provide pipe guides as specified in Section 400507 - Hangers and Supports for Process Piping, to compensate for pipe expansion due to temperature differences.

H. Field Cuts: According to pipe manufacturer instructions.

I. Joining:
   1. Heat Joining: Comply with ASTM D2657.
      a. Butt-fusion joints to be done by a factory-qualified joining technician as designated by the pipe manufacturer.
      b. Field Samples: join two sample welds on each size of pipe to be installed using the same fusion welding equipment that will be used for completion of the entire work. These sample welds will be compared to the manufacturer’s sample previously submitted in accordance with Part 1.
      c. Pipe joints with beads in excess of 3/16-in will not be approved by the Engineer.
   2. Electrofusion: Comply with ASTM F1290.
   3. Primers and Cleaners: Comply with ASTM F402.
   4. PVC Solvent-Cemented Joints: Comply with ASTM D2855.

J. Insulation: As indicated on Drawings.

K. Underground Piping: As specified in Section 331116 - Site Water Utility Distribution Piping.

3.4 INSTALLATION OF DOUBLE CONTAINMENT CHEMICAL PIPE SYSTEM

A. Double containment chemical pipe systems shall be installed in accordance with the manufacturer's technical data, printed instructions and installation instruction.

B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Design-Builder. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

C. As soon as the excavation is complete to normal grade of the bottom of the trench, screened gravel bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Screened gravel shall be placed evenly on each side of the pipe to mid diameter and hand tools shall be used to force the screened gravel under the haunches of the pipe to give firm continuous support for the pipe. Screened gravel shall then be placed to 12 inches above the top of the pipe. The initial 3 feet of backfill above the screened gravel backfill shall be placed in 1-foot layers and carefully compacted. Generally, the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial 3 feet of backfill shall be approved by the pipe manufacturer's representative prior to use.

D. All pipes shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the double containment chemical pipe systems shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation.

E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe.

F. Joints for PVC and CPVC pipe shall be solvent welded. In making solvent welded connections, clean dirt and moisture from the pipe, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by the cutting of the pipe. Solvent welded joints shall be made in accordance with ASTM D2855 and the piping manufacturer installation instructions.

G. Precautions shall be taken to prevent flotation of the pipe in the trench.

H. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element.

I. The entire length of buried chemical piping systems shall slope to the piping terminal points to allow any chemical leaks to be detected. At the terminal points, the containment piping shall extend through the building wall a distance of at least 2 inches. The terminal ends of the pipe shall be equipped with end seals consisting of a bulkhead plate of the same material as the containment pipe, solvent welded to the containment and carrier pipes. As a means of checking for and draining chemical leaks in the pipes, end seals shall be equipped with drain and vent openings with ball valves located diametrically opposite on the vertical centerline of the plate.

3.5 TOLERANCES

A. Section 014000 - Quality Requirements: Requirements for tolerances.

B. Laying Tolerances: As specified in Section 331116 - Site Water Utility Distribution Piping.

3.6 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Section 017300 “Execution”: Requirements for testing, adjusting, and balancing.

C. Inspection:
   1. Inspect for piping defects that may be detrimental as determined by the Engineer.
   2. Repair damaged piping, or provide new, undamaged pipe.
   3. After installation, inspect for proper supports and interferences.

D. Pressure Testing:
   1.

E. Pressure Testing:
   1. Test Pressure: Not less than 150 psig or 1.5 times the system’s working pressure, whichever is greater.
   2. Conduct hydrostatic test for minimum two hours.
   3. Filling:
      a. Fill section to be tested with water slowly and expel air from piping at high points.
      b. Install corporation cocks at high points.
      c. Close air vents and corporation cocks after air is expelled.
      d. Raise pressure to specified test pressure.
   4. Observe joints, fittings, and valves under test.
   5. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage and retest.
   6. Leakage:
      a. Correct visible deficiencies and continue testing at same test pressure for additional two hours to determine leakage rate.
      b. Maintain pressure within plus or minus 5 psi of test pressure.
      c. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
      d. Correct visible leaks and repeat test to verify no leaks at the required test pressures.

3.7 DOUBLE CONTAINMENT FIELD TESTING

A. All pipelines shall remain undisturbed for the minimum curing time specified for each type of pipe material but no less than 24 hours to develop full curing and complete strength at all joints. Primary carrier pipe systems shall be flushed clean and then subjected to a hydrostatic pressure test for 4 hours at 125 psig. The system pressure shall be maintained to within 5 psi of the test pressure over the entire duration of the test.

B. After testing of the carrier pipe, the containment system shall be tested pneumatically at 5 psi for a duration of 2 hours prior to backfilling. Ambient temperature needs to be greater than 40°F. All containment piping joints shall be checked for leaks by applying a soapy solution to the joints. Furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc., and complete the test to the satisfaction of the Design-Builder. Care should be taken on hot days not to exceed 5 psig.

C. After backfilling is completed, a 5 psig air test of the containment pipe shall be conducted to the satisfaction of the Design-Builder.

D. All leaks detected during the pressure test shall be repaired and the pressure/temperature test rerun.

E. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during the tests.

3.8 CLEANING

A. Sections 017300 - Execution and 017700 - Closeout Procedures: Requirements for cleaning.

B. Keep pipe interior clean as installation progresses.

C. Clean pipe interior of soil, grit, shavings, and other debris after pipe installation.

END OF SECTION 400531

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SECTION 400551 - COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Common requirements for valves.
   2. Common requirements for valve actuators.
   3. Valve tags.
   4. Valve Schedule.

B. Related Requirements:
   1. Section 033000 “Cast-in-Place Concrete” for execution requirements for placement of concrete as required by this Section.
   2. Section 055000 “Metal Fabrications” for miscellaneous metalwork and fasteners specified by this Section.
   3. Section 099100 “Painting” for product and execution requirements for painting specified by this Section.
   4. Section 220523 “General-Duty Valves for Plumbing Piping” for miscellaneous plumbing valves as required by Project.
   5. Section 331116 “Site Water Utility Distribution Piping” for valve boxes, covers, extensions, and valve extensions specified in this Section.
   6. Section 400507 “Hangers and Supports for Process Piping” for product and execution requirements for valve supports specified by this Section.
   7. Section 400593.23 “Low-Voltage Motor Requirements for Process Equipment” for single- and three-phase motor requirements for equipment specified in this Section.

1.2 COORDINATION

A. Section 013100 “Project Management and Coordination”: Requirements for coordination.

B. Coordinate Work of this Section with individual process valve specifications.

1.3 ACTION SUBMITTALS

A. Section 013300 “Submittal Procedures” for submittal requirements.

B. Valve Schedule:
   1. Submit valve schedule populated with all Division 40 process valves specified for this project. Include all information shown on the Sample Valve Schedule included in this project.
   2. Approval of valve schedule submittal to precede all individual valve submittals. All subsequent individual valve submittals to include the approved valve tag number or group on the submittal cover sheet.

C. Valve Tags:

1. Materials, dimensions and thickness of tags, materials and gauge of cable and splicing hardware.
2. Color palate for Owner selection.
3. Full scale drawing of sample with lettering dimensions and scribe depth.
4. Valve tag lettering provided with Valve Schedule above.

D. Power Actuator Data:
1. Sizing calculations
   a. Provide fluid pressure and velocity sizing basis.
   b. Provide maximum valve torque based on disc shape and flow direction.
   c. Clearly indicate safety factors and mechanical ratios of any intermediate gearing.
2. Maximum output torque of actuator and intermediate gearing.
3. Details of actuator mounting, including orientation of actuator and intermediate gearing.
4. Dimensional drawing of actuator assembled on valve.
5. Pneumatic/Hydraulic pressure requirements, electrical power supply, plumbing connection sizes and locations.
6. Wiring diagram, control wiring and protocol.
7. Valve cavitation limits for positioning, modulating and control valves mated to power actuator.

E. Shop Drawings: Valve and actuator model number and size, valve parts list, materials of each part including material standard designation (ASTM or other), position indicators, limit switches, actuator mounting.

F. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for all valves.

1.4 DELEGATED DESIGN SUBMITTALS

A. Submit signed and sealed Shop Drawings with design calculations and assumptions for sizing of control valves.

1.5 INFORMATIONAL SUBMITTALS

A. Manufacturer Instructions: Submit installation and operation instructions for each component including valve, actuator, gearbox, and any included instrumentation.

B. Source Quality-Control Submittals: Indicate results of integrators facility tests and manufacturers factory tests and inspections.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Manufacturer Certification of Installation: Certify that equipment has been installed according to manufacturer instructions.

E. Qualifications Statement:
1. Submit qualifications for manufacturer and licensed professional.

1.6 CLOSEOUT SUBMITTALS

A. Section 017700 “Closeout Procedures” for submittal requirements.

B. Section 017839 “Project Record Documents” for record actual locations of valves and actuators.

1.7 QUALITY ASSURANCE

A. Maintain clearances as indicated on the Drawings .

B. Ensure that materials of construction of wetted parts are compatible with process liquid.

C. Mate valves to actuators at manufacturer’s or integrator’s facility. Fully test assembled product and certify ready for installation prior to shipment to the job site.
   1. Only in special cases for extremely large assemblies where installation requires disassembly, may actuators be mounted to the valves in the field.

D. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

E. Furnish affidavit of compliance with testing and manufacturing standards referred in this specification and the individual valve specifications.

F. Obtain Manufacturer’s Certification of Proper Installation for Specified valves and valve assemblies.

G. Perform Work according to City of Flint Department of Public Works standards.

H. Maintain copy of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing valves and actuators with minimum ten years' documented experience.

B. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 “Product Requirements” for requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Deliver factory mated power actuated valves on rigid wooden skids, fully braced and strapped to prevent damage to valve, actuator or coupling system.

D. Store materials according to manufacturer instructions.

E. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Protect valve ends from entry of foreign materials by providing temporary covers and plugs.
3. Provide additional protection according to manufacturer instructions.

1.10 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to materials ordering or any fabrication.
2. Indicate field measurements on Shop Drawings.

1.11 WARRANTY

A. Section 017700 “Closeout Procedures”: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for valves and actuators.

PART 2 - PRODUCTS

2.1 VALVES

A. Description: Valves, operator, actuator, handwheel, chainwheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and other accessories as required.

B. All valves of the same type shall be the product of one manufacturer

C. Valve Ends: Compatible with adjacent piping system and as indicated on valve schedule.

D. Operation:
1. Close by turning clockwise for chemical service valves and counterclockwise for water service valves.
2. Cast directional arrow on valve or actuator with OPEN and CLOSE cast on valve in appropriate location.

E. Valve Marking and Labeling:
1. Marking: Comply with MSS SP-25.
2. As indicated in valve schedule.
3. Labeling (valve tags):
a. Fiberglass reinforced plastic, ASTM D709, 70 mil thick, 2 1/2-inch diameter or 2 1/2-inch by 1 ¼-inch.
b. Lettering 1/16-inch thick of silk screening or other permanent embedment of subsurface printed graphics, permanently sealed.
c. Colors of lettering and backing as selected by Owner.

d. Two, 1/4-inch clear opening 316 stainless steel grommets at each end, center of hole 3/8-inch from tag edge.
e. 3/32-inch 316 SS cable and splice hardware.

F. Valve Construction: As Specified in Valve Sections.

2.2 VALVE ACTUATORS

A. Provide actuators in accordance with the valve schedule included on the Drawings**.**

B. Provide mechanical position indicators for power actuated and gearbox actuated valves.

C. Comply with AWWA C541 (Pneumatic and Hydraulic actuators) and C542 (Electric Motor Actuators) as applicable.

D. Provide chain actuators for shutoff valves mounted greater than 7feet above operating floor level.

E. Gear and Power actuators as specified in Section 400557.00 – Actuators for Process Valves and Gates.

2.3 FINISHES

A. Valve Coating: Comply with AWWA C550.

B. Factory finishes are included in individual valve sections.

C. Exposed Valves: As specified in Section 099100 - Painting.

D. Stainless Body Valves: Do not coat.

E. Do not coat flange faces of valves unless otherwise specified.

2.4 SOURCE QUALITY CONTROL

A. Section 014000 “Quality Requirements”: Requirements for testing, inspection, and analysis.

B. Testing: Test valves according to manufacturer's standard testing protocol, including hydrostatic, seal, and performance testing.

C. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that piping system is ready for valve installation.

B. Fully examine valves for debris, damage and interior finish blemishes prior to installation. Do not install valves with soiled interior or any visible damage to seats, discs or interior finish.

C. Identify any piping, plant or equipment clearance issues prior to installation, bring to Engineer's attention via job meetings, submittal process or request for information process.

3.2 INSTALLATION

A. Install valves, actuators, extensions, valve boxes, and accessories according to manufacturer instructions in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. Inspect valve interiors before line closure for the presence of debris. At the option of the Engineer, internal inspection of valve and appurtenances may be required any time that the likelihood of debris is a possibility. Clean connecting pipes prior to installation, testing, disinfection and final acceptance.

C. Disinfect valves installed in potable water lines with approved pipeline disinfection process.

D. Rigidly support valves to avoid stresses on piping.

E. Coat studs, bolts and nuts with anti-seizing lubricant.

F. Dielectric Fittings: Provide between dissimilar metals.

G. Clean field welds of slag and splatter to provide a smooth surface.

H. Mate, adjust and fully test gearboxes, electric, hydraulic and pneumatic actuators to valves at manufacturer's or integrator's facility.
   1. Only in special cases for extremely large assemblies where installation requires disassembly may actuators be mounted to the valves in the field. These circumstances require preinstallation meetings.

I. In no case shall stems be installed vertically downward.

J. Unless otherwise indicated on the Drawings:
   1. Install Gate, Globe, Ball valves with stem vertical in the 12 o'clock position.
   2. Install Plug valves with stem horizontal and plug opening to the top of the body unless position will not allow proper actuator access, in which case stem may be vertical in the 12 o'clock position.
   3. Install Butterfly valves 12 inch and smaller with stem horizontal or vertical in the 12 o'clock position,

4. Install Butterfly valves 14 inch and larger with the stem horizontal unless position will not allow proper actuator access, in which case stem may be vertical in the 12 o'clock position.
5. Install Control valves in horizontal pipelines with top works vertically upward.

K. Install all brackets, extension rods, guides, the various types of operators and appurtenances as indicated. Before properly setting these items, check all drawings and figures which have a direct bearing on their location. The Contractor shall be responsible for the proper location of valves and appurtenances during the construction of the work

L. Inspect all materials for defects in construction and materials. Clean debris and foreign material out of openings, etc. Valve flange covers shall remain in place until connected piping is in place. Verify operability of all operating mechanisms for proper functioning. Check all nuts and bolts for tightness. Repaired or replace valves and other equipment which do not operate easily or are otherwise defective.

M. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and the Contractor shall certify such. Also note additional requirements in other parts of this Section.

N. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint. Install valves and other items as recommended by the manufacturer. Verify manufacturers' torqueing requirements for all valves.

O. Coordinate direction of flow through offset type and shaped butterfly valve discs with the mated actuator torque capacity.

P. Rotate valve operators and indicators to display toward normal operation locations. Consult with Engineer prior to installing valves with handwheels to confirm final position of handwheel.

Q. Vertically center floor boxes, valve boxes, extension stems, and low floor stands over the operating nut, with couplings as required.
1. Adjust elevation of the box top to conform to the elevation of the finished floor surface or grade at the completion of the Contract.
2. Support boxes and stem guides during concrete placement to maintain vertical alignment.

R. Install brass male adapters on each side of valves in copper-piped system and solder adapters to pipe.

S. Install ¾-inch and ball valves with cap for drains at main shutoff valves, low points of piping, bases of vertical risers, and equipment.

T. Install valves with clearance for installation of insulation and to allow access.

U. Provide access where valves and fittings are not accessible.

V. Pipe Hangers and Supports: As specified in Section 400507 - Hangers and Supports for Process Piping.

W. Comply with Division 40 - Process Interconnections for piping materials applying to various system types.

3.3 FIELD QUALITY CONTROL

A. Section 014000 “Quality Requirements”- Requirements for inspecting and testing.

B. Section 017300 “Execution” - Requirements for testing, adjusting, and balancing.

C. Valve Field Testing:
   1. Test for proper alignment.
   2. If specified by valve Section, field test equipment to demonstrate operation without undue noise, vibration, or overheating.
   3. Contractor shall take care not to over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.
   4. Engineer will witness field testing.
   5. Functional Test:
      a. Prior to system startup, inspect valves and actuators for proper alignment, quiet operation, proper connection and satisfactory performance.
      b. After installation, open and close all manual valves in the presence of the Engineer to show the valve operates smoothly from full open to full close and without leakage.
      c. Cycle valves equipped with electric, pneumatic or hydraulic actuators 5 times from full open to full closed in the presence of the Engineer to exhibit operation without vibration, jamming, leakage, or overheating.
      d. Operate pressure control and pressure relief valves in the presence of the Engineer to show they perform their specified function at some time prior to placing the piping system in operation and as agreed during construction coordination meetings.
   6. Field test pipe lines in which the valves and appurtenances are to be installed. During these tests, adjust, remove or replace defective valve or appurtenance, or otherwise make acceptable to the Engineer. Test regulating valves, strainers, or other appurtenances to demonstrate conformance with the specified operational capabilities. Correct deficiencies, replace device, or otherwise made acceptable to the Engineer.

3.4 VALVE SCHEDULE

A. None

END OF SECTION 400551

SECTION 400553 - IDENTIFICATION FOR PROCESS PIPING

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. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Requirements:
1. Section 099100 - Painting: Requirements for painting as specified by this Section.
2. Section 400551 - Common Requirements for Process Valves: Basic materials and methods for valves.

1.3 PREINSTALLATION MEETINGS

A. Section 013100 “Project Management and Coordination”: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer's catalog literature for each specified product.

C. Shop Drawings:
1. Indicate list of wording, symbols, letter size, spacing of labels, and color-coding for mechanical identification and valve chart and schedule.
2. Indicate valve tag number, location, function, and valve manufacturer's name and model number.

D. Samples: Submit two tags, labels, and pipe markers for each size to be used on Project.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

G. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 CLOSEOUT SUBMITTALS

A. Section 017700 “Closeout Procedures”: Requirements for submittals.

B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017700 “Closeout Procedures”: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish two of any materials needed to reinstall such as any adhesive containers or labeling tape for example.

C. Tools: Furnish special crimpers and other devices required for Owner to reinstall tags.

1.7 QUALITY ASSURANCE

A. Piping Color Scheme and Lettering Size: Comply with ASME A13.1.

B. Perform Work according to City of Flint Department of Public Works standards.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Craftmark Pipe Markers,
   2. Kolbi Pipe Marker Co.,
   3. Pipemarker.com (Brimar Industries, inc.),
   4. Seton Identification Products
   5. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      a. Brady ID,
      b. Craftmark Pipe Markers,
      c. Kolbi Pipe Marker Co.,
      d. Marking Services, Inc.,
      e. R&R Identification Co.
      f. Seton Identification Products
      g. Substitutions: As specified in Section 016000 - Product Requirements.
   2. Description:
      a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
      b. Minimum Tag Size and Configuration: 2 inches; diameter.
      c. Provide with brass hooks suitable for attaching the tag to the valve operator.
      d. Stamp or etch tags with the valve number and information on the valve schedule coded in a system provided by the Owner.

B. Metal Tags:
   1. Manufacturers:
      a. Brady ID,
      b. Craftmark Pipe Markers,
      c. Kolbi Pipe Marker Co,
      d. Marking Services, Inc.,
      e. Pipemarker.com (Brimar Industries, Inc.),
      f. R&R Identification Co.
      g. Seton Identification Products
      h. Substitutions: As specified in Section 016000 - Product Requirements.
   2. Description:

a. Stainless-steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 2 inches; diameter with finished edges.
c. Provide with brass hooks suitable for attaching the tag to the valve operator.
d. Stamp or etch tags with the valve number and information on the valve schedule coded in a system provided by the Owner.

C. Information Tags:
1. Manufacturers:
a. Brady ID,
b. Seton Identification Products
c. Substitutions: As specified in Section 016000 - Product Requirements.
2. Description:
a. Clear plastic with printed text.
b. Minimum Tag Size: 3-1/4 by 5-5/8 inches.
c. Furnish grommet and self-locking nylon ties.
3. Tag Chart: Typewritten, letter-size list of applied tags and location, plastic laminated.

2.3 STENCILS

A. Manufacturers:
1. Kolbi Pipe Marker Co,
2. Marking Services, Inc.,
3. Pipemarker.com (Brimar Industries, Inc.),
4. R&R Identification Co.
5. Seton Identification Products
6. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Quality: Clean-cut symbols.
2. Letters:

OUTSIDE DIAMETER OF PIPE	SIZE OF LETTERS
3/4-in to 1-1/4-in	1/2-in
1-1/2-in to 2-in	3/4-in
2-1/2-in to 6-in	1-1/2-in
8-in to 10-in	2-1/2-in
Over 10-in	3-in

C. Stencil Paint:
1. Description: Semigloss enamel.
2. As specified in Section 099000 - Painting and Coating.

2.4 PIPE MARKERS

A. Plastic Pipe Markers:
1. Manufacturers:
a. Brady ID,
b. Craftmark Pipe Markers,

c. Marking Services, Inc.,
d. R&R Identification Co.,
e. Seton Identification Products Substitutions: As specified in Section 016000 - Product Requirements.

2. Description:
a. Factory-fabricated, flexible, and semi-rigid plastic.
b. Preformed to fit around pipe or pipe covering.
c. Larger sizes may be of maximum sheet size, with spring fastener.
d. Letter sizes per Paragraph 2.3B.
e. Color shall be white or black depending on background color.

B. Plastic Tape Pipe Markers:
1. Manufacturers:
a. Brady ID,
b. Craftmark Pipe Markers,
c. Kolbi Pipe Marker Co.,
d. Marking Services, Inc.,
e. Pipemarker.com (Brimar Industries, Inc.),
f. Seton Identification Products
g. Substitutions: As specified in Section 016000 - Product Requirements.
2. Description:
a. Flexible, 3.5 mil vinyl ilm tape with pressure-sensitive adhesive backing and printed markings.
b. Letter sizes per Paragraph 2.3B.
c. Color shall be white or black depending on background color.

C. Plastic Underground Pipe Markers:
1. Manufacturers:
a. Kolbi Pipe Marker Co.,
b. Marking Services, Inc.,
c. Pipemarker.com (Brimar Industries, Inc.),
d. Rhino Marking and Protection System,
e. Seton Identification Products
f. Substitutions: As specified in Section 016000 - Product Requirements.
2. Description:
a. Brightly colored, continuusly printed plastic ribbon tape.
b. Minimum Size: 6 inches wide by 4 mils thick.
c. Manufactured for direct burial service.
d. Letter sizes per Paragraph 2.3B.

2.5 LABELS

A. Manufacturers:
1. Brady ID,
2. Seton Identification Products
3. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Material: Laminated Mylar.
2. Minimum Size: 1.9 by 0.75 inches.

3. Adhesive backed, with printed identification.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Manufacturers:
      a. Brady ID,
      b. Master Lock Company, LLC
      c. Substitutions: As specified in Section 016000 - Product Requirements.
   2. Description:
      a. Material: Reinforced nylon.
      b. Furnish hasp with erasable label surface.
      c. Minimum Size: 7-1/4 by 3 inches.

B. Valve Lockout Devices:
   1. Manufacturers:
      a. Brady ID,
      b. Master Lock Company, LLC
      c. Substitutions: As specified in Section 016000 - Product Requirements.
   2. Description:
      a. Material: Nylon or Plastic.
      b. Furnish device to restrict access to valve operator and to accept lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Section 017300 “Execution”: Requirements for installation preparation.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Stencil Painting: Prepare surfaces as specified in Section 099000 - Painting and Coating.

3.2 INSTALLATION

A. According to manufacturer instructions.

B. Apply stencil painting as specified in Section 099000 - Painting and Coating.

C. Install identifying devices after completion of coverings and painting.

D. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

E. Labels:
   1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
   2. For unfinished covering, apply paint primer before applying labels.
   3. Titles:
      a. Locate a maximum 26 feet apart.

b. Locate directly adjacent to pipeline breaches on each side wall.
c. Locate adjacent to each side of the valve regulator, flow meter, strainer, cleanout and all pieces of equipment.
d. Identify the contents by complete name at least once in each room or space and thereafter may be labeled by generally recognized abbreviations.

F. Tags:
1. Identify valves in main and branch piping with tags.
2. Install tags using corrosion-resistant chain.
3. Number tags as indicated in tag schedule.

G. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

H. Piping:
1. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers.
2. Identify service, flow direction, and pressure.
3. Install in clear view and align with axis of piping.
4. Locate identification not to exceed 20 feet on straight runs, including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

I. Ceiling Tacks:
1. Provide ceiling tacks to locate valves above T-bar-type panel ceilings.
2. Locate in corner of ceiling panel closest to equipment.

END OF SECTION 400553

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SECTION 400563 - BALL VALVES

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. Plastic ball valves.

B. Related Requirements:
   1. Section 220523 - General-Duty Valves for Plumbing Piping: Miscellaneous plumbing valves as required by Project.
   2. Section 400551 - Common Requirements for Process Valves: Basic materials and methods related to valves commonly used for process systems.

1.3 SUBMITTALS

A. As specified in Section 400551 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

1.4 QUALITY ASSURANCE

A. Test valves in accordance with AWWA C504, API 598, MSS SP61 as applicable for types listed herein.

B. Provide Installation Inspection and Operator Training per Section 400551.

C. Provide testing and inspection certificates.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC BALL VALVES

A. Manufacturers:
   1. George Fischer, ASAHI, Spears.
   2. Substitutions: As specified in Section 016000 - Product Requirements.

B. General

1. All valves shall be certified as completely compatible with the intended and specified service; compatibility shall apply to the material of the valve and internal components, including all seals, gaskets, O-rings and washers; solvents and primers used in valve joint make up shall be specifically in conformance with the written instructions of the valve supplier. Service chemicals and service conditions are shown in the piping sections in Division 40 and on the Drawings. **For all valves that are provided for chemical services, submit a letter stating that material of construction is fully compatible with the chemical services. The letter shall state that the manufacturer has reviewed the Safety Data Sheets (SDS) sheets of all the chemical contents including the summary of hazards, and physical and chemical data. Contractor shall request SDS sheets of all chemicals from the City and provide to the valve manufacturer.**
2. Except as otherwise specified valve ends shall be socket type designed for solvent welding. Solvent and primer shall be as specified in the piping specifications, except that valves installed in systems carrying strong oxidizing, high alkalinity, and strong acid solutions shall contain NO fumed silica, and shall be Weld-On 724 for CPVC pipe as manufactured by IPS Corp., Compton, CA, and Oatey Industrial Grade Low VOC Heavy Duty Gray for PVC pipe as manufactured by Oatey Corp., Cleveland OH.
3. Valve material shall be the same as the piping service except as specified.
   a. PVC shall be Type 1, Grade 1, per ASTM D1784 classification, made from unplasticized polymer, and generally suitable for service to 120°F.
   b. CPVC shall be Type 4, Grade 1, per ASTM D1784, classification generally suitable for service to 180°F.
   c. Polypropylene (PP) shall conform to the material requirements of ASTM D4101 for copolymer polypropylene.
   d. PVDF (polyvinylidene fluoride) shall be manufactured from high molecular weight polymers of vinylidene fluoride.
   e. The manufacturer of the valves shall retain material source quality documentation and shall furnish it to the Design-Builder upon request.
4. Unless otherwise specified:
   a. O-rings, valve seats and stem seals shall be Teflon, or Teflon encapsulated elastomer. Alternative materials shall not be substituted without complete documentation provided to the Design-Builder of service suitability.
   b. Flange Gaskets shall be low torque, full face ANSI B16.5 with two concentric convex rings between ID and bolt hole diameter, constructed of EPDM, PTFE bonded EPDM or PVDF-bonded EPDM as manufactured by Asahi of America or equal. Documentation shall be provided to show compatibility of the bonded surface material for the fluid service intended.
   c. Valve external hardware shall be Type 316 stainless steel. No internal metallic components shall be exposed to the service fluid.
   d. No factory or field coatings shall be applied to the valves; except valve bodies for required piping color codes. Do not coat valve nameplate!
5. All valves shall be given hydrostatic and pressure and leakage tests at the factory. Provide certified copy of test results.

C. Description:

1. Working Pressure: 120 psig at 70 deg. F.
2. Maximum Process Fluid Temperature: 100 deg. F.
3. Ports: Full size.
4. End Connections:
   a. Double Union, adjustable seats

5. Provide quarter turn manual valve operator unless mechanized actuators are specified on the drawings.
6. Ball valves for sodium hypochlorite service shall be PVC body, furnished with socket ends, Viton B O-rings and stem seals, PTFE seats with Viton B O-ring backup. Sodium hypochlorite service ball valves shall have ball drilled to permit venting of pressure and gas from confined ball cavity, when valve is closed. Drilling shall vent to vented portion of piping in which valve is installed. Drilling shall be 1/8-inch opening, de-burred and drilled by factory only. Directional indicator arrow labels shall be provided on valve body to indicate flow/vent. Field-drilled opening is not allowed.

D. Operator: Hand lever and Electrically actuated..

E. Materials:
1. Body and Ball: PVC, ASTM D1784
2. Seats: PTFE.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. As specified in Section 400551 - Common Requirements for Process Valves.

C. Testing: Test ball valves according to AWWA C507.

PART 3 - EXECUTION

3.1 INSPECTION

A. As specified in Section 400551 - Common Requirements for Process Valves: Submittal requirements for compliance with this Section.

3.2 INSTALLATION

A. All materials shall be carefully inspected for defects in construction and materials. All debris and foreign material shall be cleaned out of openings, etc. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

B. Unless otherwise noted, all operational devices shall be installed with the units of the factory, as shown on the Drawings or as acceptable to the Engineer to allow accessibility to operate and maintain the item and to prevent interference with other piping, valves, and appurtenances.

C. For manually operated valves 3 inches in diameter and smaller, valve operators and indicators shall be rotated to display toward normal operation locations.

D. As specified in Section 400551 – Common Requirements for Process Valves.

END OF SECTION 400563

SECTION 400567.39 - PRESSURE-RELIEF VALVES

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. Spring-loaded pressure-relief valves.

B. Related Requirements:
   1. Section 400551 - Common Requirements for Process Valves
   2. Section 434111 - Bolted Steel Tanks: Tank construction and appurtenances.
   3. Section 434113 - Welded Steel Tanks: Tank construction and appurtenances.
   4. Section 434145 - Fiberglass Reinforced Plastic Tanks: Tank construction and appurtenances.
   5. Section 434221 - Welded Steel Pressure Tanks: Tank construction and appurtenances.

1.3 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with installation of process tanks and/or piping.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Section 400551 - Common Requirements for Process Valves.

C. Product Data: Submit manufacturer catalog information.

D. Shop Drawings: Indicate materials (by common name and ASTM number), size, accessories, and dimensions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer Instructions: Submit special procedures and setting dimensions.

G. Source Quality-Control Submittals: Indicate results of factory tests and inspections and provide required certifications.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Qualifications Statement:
   1. Submit qualifications for manufacturer.

J. American Iron and Steel (AIS): Submit certification indicating compliance with AIS requirements.

1.5 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of pressure-relief valves.

1.6 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF Standards 61 and 372.

B. Maintain copy of each standard affecting Work of this Section on Site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years' documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Section 400551 – Common Requirements for Process Valves.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Store materials according to manufacturer instructions.

E. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Furnish temporary end caps and closures on piping and fittings and maintain in place until installation.
   3. Provide additional protection according to manufacturer instructions.

1.9 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.10 WARRANTY

A. Section 017700 - Closeout Procedures: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for pressure-relief valves.

PART 2 - PRODUCTS

2.1 PRESSURE-RELIEF VALVES, SPRING LOADED – Tag Type PRV

A. Manufacturers:
1. Asahi-America, Plast-O-Matic
2. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Size: As indicated on Drawings
2. Spring opposed, angle-pattern design with adjustable relief pressure and locking nut.
3. Performance and Design Criteria:
   a. Flow Capacity: 0.2 to 12 gph at 90 psig pressure setting.
   b. Maximum Pressure Setting: 100 psig.
   c. Pressure Setting Available Range: 100 psig
4. Materials:
   a. Body: Same material as pipeline in which valve is installed.
   b. Trim: .
   c. Spring: Elastomer-coated and isolated from process flow. Elastomer shall be compatible with fluid service.
   d. Diaphragm shall be reinforced Teflon.
   e. Seat: PTFE.
5. End Connection: solvent welded

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 - Execution: Requirements for installation examination.

B. Verify that field dimensions are as indicated on Drawings.

3.2 PREPARATION

A. Section 017300 - Execution: Requirements for installation preparation.

B. Thoroughly clean end connections before installation.

C. Cleaning: Clean surfaces to remove foreign substances.

3.3 INSTALLATION

A. According to manufacturer instructions and local code requirements.

B. Repair damaged coatings with material equal to original coating.

C. Section 400551 – Common Requirements for Process Valves

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Testing: Test each valve for leak tightness at 75 percent of set point according to API 2000.

C. After installation, inspect for interferences and proper supports.

D. Repair damaged coatings with material equal to original coating.

3.5 CLEANING

A. Sections 017300 “Execution” and 017700 “Closeout Procedures”: Requirements for cleaning.

B. Keep interior of valves clean as installation progresses.

3.6 DEMONSTRATION

A. Section 017900 - Demonstration and Training: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 400567.39

SECTION 400582 - SOLENOID VALVES FOR PROCESS SERVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Solenoid valves for process applications.

B. Related Requirements:
   1. Section 400593.23 - Low-Voltage Motor Requirements for Process Equipment
   2. Section 400551 - Common Requirements for Process Valves: Basic materials and methods related to valves commonly used for process systems.
   3. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with process piping Work as specified in other Sections and as indicated on Drawings. Note that solenoid valves may be shown on Electrical and/or Mechanical Drawings, or may only be specified, but if so specified or shown, shall be provided. Solenoid valves located in hazardous classified areas shall be provided with electrical enclosures which satisfy the electrical classification as specified or shown on the electrical drawings.

1.3 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information, indicating materials of construction, wiring diagrams, and compliance with indicated standards.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

B. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

C. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

D. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 QUALITY ASSURANCE

A. Materials in Contact with Potable Water: Certified to NSF 61 and NSF 372.

B. Perform Work according to City of Flint Department of Public Works standards.

C. Maintain copy of each standard affecting Work of this Section on Site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.8 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.9 WARRANTY

A. Section 017700 “Closeout Procedures”: Requirements for warranties.

B. Furnish five -year manufacturer's warranty for solenoid valves.

PART 2 - PRODUCTS

2.1 SOLENOID VALVES – Tag Type SV

A. Manufacturers:

1. Solenoid valves less than 2”: Red Hat Valve by ASCO Valve, similar by Circle Seal Controls-Atkomatic Valve Co.
2. Solenoid valves 2” or greater: Type A by Magnatrol Valve Corp
3. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Type: As indicated in valve schedule.
2. Minimum Working Pressure: 150 psig at 70 degrees F.
3. Minimum Working Pressure Differential: 0 psig at 70 degrees F.
4. Maximum Fluid Temperature: 100 degrees F.
5. Coil: Continuous duty.
6. Operation: Fail open, energize to close.
7. Enclosures: NEMA 250 Type 4x rated according to area designation as indicated on Drawings.
8. Electrical Characteristics: As indicated on Drawings.
9. End Connections: Threaded or as indicated on the drawing.
10. Conduit Connection: or as indicated on the drawings.
11. Valves 2” in size or larger shall include a manual override actuated by a handle-levered plunger mounted to the bottom of the valve body. These valves must be mounted in a horizontal run of piping, with the solenoid up in the vertical position.

C. Materials:
1. Body: Bronze, ASTM B62.
2. Trim and Spring: Stainless steel.
3. Seals: PTFE or Buna-N or Ethylene Propylene.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Owner Inspection:
1. Make completed solenoid valves available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:
1. Allow witnessing of factory inspections and test at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. As specified in Section 400551 - Common Requirements for Process Valves.

B. Install protective strainers upstream of solenoid valves, pressure-reducing valves, and pressure-sustaining valves.

3.2 FIELD QUALITY CONTROL

A. As specified in Section 400551 - Common Requirements for Process Valves.

END OF SECTION 400582

SECTION 400593.23 – LOW-VOLTAGE MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

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. Three-phase motors for application on process equipment provided under other Sections.

B. The manufacturer of the driven equipment shall provide the associated motor.

C. Related Requirements:
   1. Section 260526 - Grounding and Bonding for Electrical Systems.
   2. Section 260553 - Identification for Electrical Systems.
   3. Section 262923 - Variable-Frequency Motor Controllers.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

B. VFC: Variable-frequency motor controller. See VFD.

C. VFD: Variable-frequency drive. Used interchangeably with the term VFC.

1.4 SUBMITTALS

A. Product Data: For each type and rating of motor indicated.
   1. Include construction details, material descriptions, dimensions, profiles, and finishes.
   2. Include nameplate data, compliance with specified standards, electrical ratings and characteristics, physical dimensions, frame size, weights, mechanical performance data, support points and the following:
      1. Descriptive bulletins, including full description of insulation system.
      2. Bearing design data.
      3. Efficiency at ½, ¾ and full load.
      4. Power factor at ½, ¾ and full load.
      5. Conduit entry points and sizes.
      6. Special features and accessories (i.e., space heaters, temperature detectors, etc.).

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Qualifications Statements:

1. Submit qualifications for manufacturer and testing agency.

1.5 QUALITY ASSURANCE

A. Electric motors driving identical equipment shall be identical

B. Motors shall be listed under UL recognized component file as applicable.

C. Motor manufacturer to maintain a documented ISO 9001 quality assurance program implementing suitable procedures and controls to monitor all aspects of production and testing.

D. When electrically driven equipment differs from that indicated, adjust the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed.

E. Testing Agency Qualifications: Member company of NETA.

1.6 DELIVERY, STORAGE AND HANDLING

A. Ship motor fully assembled, capable of being lifted in one piece. Comply with Section 016000, "Product Requirements" for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on site in manufacturer's original packaging and inspect for damage.

C. Storage:
1. Store materials according to manufacturer instructions.
2. Energize motors furnished with space heaters to prevent condensation throughout the storage and construction period. Perform periodic motor insulation resistance tests per manufacturer’s storage recommendations.
3. For extended outdoor storage, remove motors from equipment and store separately.
4. Maintain bearings during storage and construction period, and periodically rotate the motor shaft per manufacturer’s storage recommendations.
5. Lubricate per manufacturer’s recommendations and inspect purged grease for water, rust, or other contaminants.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
1. Nidec (US Motors)
2. ABB (Baldor-Reliance)

3. TECO-Westinghouse
4. Toshiba
5. WEG
6. General Electric
7. Or equal

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with the latest revision of the following as applicable:
   1. NEMA MG 1, Motors and Generators.

C. Unless otherwise noted, all motors ½ through 100 horsepower shall be rated 460 Volt, three-phase, 60 Hertz A.C.; and motors below ½ horsepower shall be rated 115/200 Volt, single phase, 60 Hertz A.C.

D. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

E. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

F. Horsepower rating: Size for operation within the full load nameplate rating without applying the service factor, throughout the full range of mechanical or hydraulic operating condition.

G. Specific motor application data such as Hp, rpm, enclosure type, accessories, etc., are specified under the detailed driven mechanical equipment specification.

H. Nameplates: Engrave or emboss on 316 stainless steel fastened to the motor frame with stainless steel screws or drive pins with information per NEMA MG 1.

I. Service Factor: 1.15 service factor on sine wave power and 1.0 service factor on VFD power in a 40 degrees C ambient, unless otherwise noted.

J. Motors and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

K. Enclosures: Conform to one of the NEMA standard enclosure designs as specified under the detailed driven mechanical equipment specification. If no enclosure type is specified, provide TEFC (Totally Enclosed Fan Cooled) enclosures.

L. Motors connected to VFCs: Inverter duty rated and comply with NEMA MG 1, Part 31. First or second torsional critical speed shall be outside the operating speed range for all VFC controlled motors.

M. Three-phase motors:
   1. Description: NEMA MG 1, Design B, medium induction motor.

2. Efficiency: Meet or exceed requirements for NEMA MG 1, Part 12 for Premium Efficient motors 1 HP and larger.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
    1. For motors with 2:1 speed ratio, consequent pole, single winding.
    2. For motors with other than 2:1 speed ratio, separate winding for each speed.
5. Rotor: Random-wound, squirrel cage.
6. Code Letter Designation:
    1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
7. Accessories: Where specified herein, or under process mechanical specification.

2.3 THREE PHASE MOTOR CONSTRUCTION

A. Enclosure and Frame:
1. NEMA enclosure type as specified in the process equipment specification.
2. NEMA frame for the associated horsepower.
3. Motor frames: Cast iron or welded heavy plate steel construction, stiff enough to withstand the rotating forces and torques generated and designed to limit or avoid any undesirable harmonic resonances.
4. Provide a threaded, forged steel, shouldered eyebolt blind tapped into the motor frame for lifting on all frames 254T and larger.
5. Condensate drain openings: Locate drain holes at the low points in the end brackets to allow removal of accumulated moisture from enclosures. Provide corrosion resistant, breather drain plugs for severe-duty motors.
6. Hardware: Hex head, SAE Grade 5 or better, plated for corrosion protection.
7. Nameplates: Engraved or embossed stainless steel plates fastened to the motor frame with stainless steel screws or drive pins. Clearly indicate all items of information listed in the applicable part of NEMA MG 1.
8. Main terminal box: Fabricated steel or cast iron, sized per the NEC for number and size of conduit connections and conductor bending and terminations as indicated on the Drawings. Split box top to bottom with capability to rotate entry point to any quadrant. Provide gaskets between the box and motor frame and between box and its cover. Include ground lug for equipment grounding conductor termination.
9. Bearing housings: Provide machined surfaces for attaching a magnet mounted accelerometer to monitor the motor vibration in the vertical, horizontal, and axial directions at each bearing housing.
10. Frame grounding: provide motor frame grounding pad or threaded stud where supplemental grounding to frame is indicated on the drawings.
11. Corrosion resistant mill and chemical duty paint.

B. Windings:
1. Copper
2. Insulation rating: Class F.
3. Temperature rise: Class B at 1.0 SF, Class F at 1.15 SF.
4. Insulation: Non-hygroscopic, epoxy encapsulated windings for enclosure types WP I and WP II. Provide upgraded insulation by additional dips and bakes to increase moisture resistance for totally enclosed designs. Provide vacuum pressure impregnated (VPI) epoxy insulation for moisture resistance for outdoor motors.

5. Provide chemical and humidity resistance insulation system when IEEE 841 motors are specified.
6. Provide winding surge withstand capability per NEMA 1, Part 31 for VFC driven motors.
7. Provide specified temperature sensing devices for VFC driven equipment. If not specified, provide a winding temperature detector per the accessories paragraph.

C. Motor leads: Non-wicking type, minimum Class F temperature rating and permanently numbered for identification.

D. Stator: Built up core using high grade, low loss silicon steel laminations keyed or dovetailed to the stator frame and securely held in place at each end.

E. Rotor:
1. Forged or rolled steel shaft, machined, smooth finished, with sufficient strength for operation including 25 percent overspeed condition.
2. Shaft end coordinated with driven equipment coupling.
3. Entire assembly coated with protective coating.
4. Inpro seals on both ends of the shaft to prevent grease leakage and entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest. Severe duty motors to have improved sealing per IEEE 841.

5. Vertical Motor Shafts:
    1. Provide hollow shaft and P flange mounting to allow driven shaft to extend through provide for vertical pump applications.
    2. Coupling for connecting the motor shaft to the driven shaft is located in the top of the motor.
    3. Where solid shaft is provided couple the driven shaft below the P flange face.

6. Rotor Core:
    1. Solid, built-up stack of fully processed and coated, high-grade, low-loss silicon steel laminations.
    2. Die cast aluminum or fabricated copper bars or their respective alloys.
    3. Rotors on frames 213T and above to be keyed to shaft and rotating assembly dynamically balanced.

7. Rotor Assembly:
    1. Coated with corrosion resistant epoxy insulating varnish or other protective coating, thermally stable, statically and dynamically balanced.
    2. Balance weights securely attached to the rotor resistance ring by welding or similar permanent method.

F. Horizontal Bearings: roller type, grease lubricated.
1. Bearings: Anti-friction open or single-shield, vacuum-degassed steel ball or roller bearings, electric motor quality, designed for 45 degrees C maximum temperature rise. Metric size bearings are not acceptable.
2. Life: L 10 life of 100,000 hours for direct coupled applications and 26,000 hours for belted applications based. IEEE 841 motors, L 10 life increased to 150,000 and 50,000 hours respectively.
3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
4. Shaft currents: Provide mitigation per process equipment specification.

5. Comply with ABMA and refer to process equipment specification for stricter or additional requirements.

G. Vertical Bearings: per manufacturer, thrust type.
1. Bearings: Manufacturer's standard design, constructed with thrust bearings on top to allow inspection and/or replacement without requiring complete disassembly of motor, of type and size to satisfy thrust loading requirements.
2. Life: Rated for an in-service L 10 life of 8800 hours, designed to support the weight of the rotor plus, if required, the weight of the rotating driven equipment parts and the hydraulic thrust created by the driven equipment, with a 40 degrees C maximum temperature rise. Metric bearings are not acceptable.
3. Shaft seals: Provide to prevent grease leakage and the entrance of foreign materials, such as water and dirt, into the bearing area while running, coasting, or at rest.
4. Shaft currents: Provide mitigation per process equipment specification.
5. Comply with ABMA and refer to process equipment specification for stricter or additional requirements.

2.4 THREE PHASE MOTOR ACCESSORIES

A. Winding temperature switch: Three embedded bi-metallic temperature thermostat switches with normally closed contacts and leads terminating in the main conduit box.

B. Bearing temperature sensing: Number, type, and location for motor and driven equipment per process equipment specification.
1. RTD: Replaceable 100 Ohm platinum (PT 100) three-wire RTD's, with spring loaded tip. Mount RTD as close as possible to outer surface of each bearing. RTD includes conduit connection head, terminal block, and cabling brought out to a common terminal box.
2. Dial type thermometer.
3. Temperature relay furnished with indicating scale.
4. Iron or copper constantan thermocouple.

C. Shaft grounding rings: maintenance free, circumferential micro fiber type, AEGIS™ SGR by electro Static Technology or equal to discharge shaft currents to ground.

D. Encoder for vector drive motors: Provide encoder on opposite drive end to sense rotor speed and provide closed loop feedback (quadrature signal with line driver output) to a control device. Provide sufficient length of encoder cable to connect encoder to variable frequency controller.

2.5 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Factory Testing: Prior to shipment perform manufacturer’s standard tests in accordance with NEMA MG 1 and IEEE 112.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Upon delivery of motor and prior to unloading, inspect equipment for damage.

B. Comply with DELIVERY, STORAGE, AND HANDLING article within this specification.

3.2 INSTALLATION

A. Prepare rigid foundation or mounting surface to minimize vibration and maintain alignment between motor and load shaft.

B. Install the motors per manufacturer's installation instructions.

C. Anchor motor base to load bearing surface with grade 5 steel bolts or better.

D. Align the motor shaft with driven equipment according to manufacturer’s written instructions. Adjust axial position of motor frame with respect to load shaft.

E. Accurately adjust flexible couplings for direct drive according to machine manufacturer’s guidelines. Check alignment to minimize vibrations. Coupling spacing shall be according to coupling manufacturer guidelines.

F. Install motor branch circuit conduits and conductors in accordance with NEC and local code requirements. Connect motors to rigid conduit system by a short section of liquid-tight flexible conduit to isolate the conduit system from motor vibration. Where motors are installed outdoors, bring conduit into bottom of motor terminal box to avoid standing water at connection point.

G. Terminate the motor leads as shown on the connection diagrams using products intended for vibration applications.

H. Ground equipment according to Section 26056, “Grounding and Bonding for Electrical Systems.”

I. Tighten electrical connections and terminals according to manufacturers' published torque values.

J. Install conduit and wiring between motor auxiliary devices and associated indicators, controllers and protective devices in accordance to installation drawings.

K. Connect devices sensitive to electromagnetic interferes such as RTD's, thermistors, thermal protector switches, vibration sensors with shielded instrumentation wiring per installation drawings.

L. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553, "Identification for Electrical Systems." Identify field-installed conductors, interconnecting wiring, and components.

3.4 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until motors are ready to be energized and placed into service.

B. Lubrication and Shaft Rotation: Lubricate parts and rotate shaft periodically according to manufacturer’s written instructions until motors are ready to be energized and placed into service.

3.5 FIELD QUALITY CONTROL

A. Perform inspections and tests Inspect and test according to the Inspection and Test Procedures for Rotating Machinery state in NETA Acceptance Testing Specification paragraph 7.15.1. Options tests are not required unless called for within the process equipment specification.

B. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Motors will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies the motor and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP AND ADJUSTMENT

A. Complete installation and startup checks according to manufacturer's written instructions. Confirm motor is structurally, mechanically, and electrically ready for start-up. Checks include support system, vibration isolation, alignment, lubrication system, and cleanliness.

B. Start-up motor in accordance with process equipment specification.

C. Verify correct phase rotation at motor with driven equipment uncoupled. Correction for phase rotation to be made in the motor terminal box.

D. Prepare inspection and test reports.

3.7 DEMONSTRATION / SYSTEM FUNCTION TESTS

A. Run motor for system testing as required in motor controller and driven equipment specifications.

B. Confirm correct operation of all protective and metering devices.

C. Measure voltage and motor running current and evaluate relative to load conditions and nameplate full load amperes. Corrective action is required for any current imbalance 10 percent or greater.

D. Prepare driven equipment system testing report. Include results of all tests and check made, meter readings and recordings, and summary adjustments made. Clearly identify any discrepancies and concerns.

END OF SECTION 400593.23

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SECTION 404113.13 - PROCESS PIPING ELECTRICAL RESISTANCE HEAT TRACING

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. Self-regulating cables.
   2. Heat-tracing controls.

B. Related Requirements:
   1. Division 26 for electrical requirements.

1.3 DEFINITIONS

A. Self-Regulating Index (SRI): The rate of change of power output in Watts per degree F, as measured between the temperatures of 50 and 100 degrees F.

1.4 COORDINATION

A. Section 013100 - Project Management and Coordination: Requirements for coordination.

B. Coordinate Work of this Section with installation of process piping and installation of piping insulation.

1.5 PREINSTALLATION MEETINGS

A. Section 013100 - Project Management and Coordination: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.6 ACTION SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturer information for system materials and component equipment, including thermal properties, electrical characteristics, and connection requirements.

C. Shop Drawings:
   1. Indicate system materials and component equipment.
   2. Submit wiring and control diagrams, installation and anchoring requirements, fasteners, and other details.

1.7 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

B. Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.

C. Source Quality-Control Submittals: Indicate results of shop tests and inspections.

D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

E. Manufacturer Reports: Certify that equipment has been installed according to manufacturer instructions.

F. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.8 CLOSEOUT SUBMITTALS

A. Section 017700 - Closeout Procedures: Requirements for submittals.

B. Project Record Documents: Record actual locations of piping and appurtenances receiving heat tracing, and locations of source power and controls.

1.9 QUALITY ASSURANCE

A. Perform Work according to State of Michigan standards.

1.10 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

C. Store materials according to manufacturer instructions.

D. Protection:
1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.12 EXISTING CONDITIONS

A. Field Measurements:
1. Verify field measurements prior to fabrication.
2. Indicate field measurements on Shop Drawings.

1.13 WARRANTY

A. Section 017700 “Closeout Procedures”: Requirements for warranties.

B. Furnish five-year manufacturer's warranty for heat tracing and components.

PART 2 - PRODUCTS

2.1 SELF-REGULATING CABLE

A. Manufacturers:
1. Substitutions: As specified in Section 016000 - Product Requirements.
2. Raychem/Pentair Thermal/Chemelex,
3. Chromolox
4. Thermon

B. Description:
1. Bus Wires:
a. Quantity: Two.
b. Orientation: Parallel.
c. Material: Nickel-coated copper.
d. Minimum Size: 16 gage.
2. Heating Element: Self-regulating polymeric core.
3. Jacketing:
a. Description: Tinned copper braid with resistance less than cable bus wire resistance.
b. Comply with ASTM B193.
c. Insulating Jacket: Fluoropolymer.
4. Cable Temperature Identification Number (T-Rating):
a. T6, without use of thermostats.
b. Comply with NEC.
5. Output:
a. As indicated on Drawings.
b. Minimum 5 W/ft..

C. Performance and Design Criteria:

1. Power Output: Vary relative to temperature of surface of pipe or appurtenance.
2. Cable can be cut to length on Site.
3. Minimum SRI:
   a. Cable Rating 5 W/ft.: 0.060 W/degrees F.

D. Operation:
1. Electrical Characteristics:
   a. Voltage: 120V, single phase, 60 Hz.
   b. Maximum Circuit Breaker Size: 15A.
   c. Ground-Fault Protection Device: Set at 30 mA, with nominal 100-ms response time, to protect each circuit.
2. Disconnect Switch: Located adjacent to the heat trace cables.

E. Accessories:
1. Splicing connectors.
2. End terminations.
3. T-connectors.
4. Power termination kits.

2.2 HEAT-TRACING CONTROLS

A. Single Thermostat:
1. Description: Stainless-steel remote bulb with 6-foot capillary encased in flexible stainless-steel armor.
2. Housing:
   a. FM approved.
   b. Rating: NEMA 250 Type 4X.
3. Set-Point Range: 35 to 235 degrees F.

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing:
1. Retain at least 75 percent of rated power after 20 years of operation at maximum published continuous exposure temperature.
2. Retain at least 90 percent of rated power after 1,000 hours of operation at maximum published intermittent exposure temperature.
3. Cable Dielectric Test: Passing 2.5 kV dielectric test for one minute according to ASTM D2633 after undergoing a 0.5 kg-m impact.
4. Before shipment, demonstrate cable insulation resistance of 20 megohms minimum bus to braid using a 2,500-V dc megger, and demonstrate tolerance for one minute at voltage equal to twice rated plus 1,000 V applied bus to braid.
5. Thermal Runaway:
   a. Ensure that cable produces less than 0.5 W/ft. when energized and heated to 350 degrees F for 30 minutes.
   b. After testing and reenergizing, demonstrate that cable does not have an increasing power output leading to thermal runaway.

C. Certificate of Compliance:
   1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017300 “Execution”: Requirements for installation examination.

B. Verify that surfaces of pipes, valves, and fittings are clean and dry.

C. Verify that piping has been inspected and is ready for insulation.

3.2 INSTALLATION

A. Install heat tracing before insulation is installed.

B. Install equipment according to manufacturer instructions.

C. If required, spiral heat-trace cable around piping to obtain proper heating per length of piping.

D. Do not overlay cable over cable.

E. Cover installed heating cable with thermal insulation and waterproof jacketing as soon as possible.

F. Affix following label to exterior of thermal insulation every 15 feet and readily visible from ground level: CAUTION: ELECTRIC HEAT TRACING.

3.3 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. After installation, inspect for proper operation.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products furnished under this Section for not less than 8 hours on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

D. Equipment Acceptance:
   1. Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.
   2. Make final adjustments to equipment under direction of manufacturer's representative.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.4 ADJUSTING

A. Section 017300 - Execution: Requirements for starting and adjusting.

B. Check control functions and adjust as required.

3.5 DEMONSTRATION

A. Section 017900 - Demonstration and Training: Requirements for demonstration and training.

B. Demonstrate equipment startup, shutdown, routine maintenance, and emergency repair procedures to Owner's personnel.

END OF SECTION 404113.13

SECTION 406100 - PROCESS CONTROL AND ENTERPRISE MANAGEMENT SYSTEMS GENERAL PROVISIONS

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 procurement of the services of a Process Control System Supplier (PCSS) to furnish and install all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein, in “Related Requirements” under this Article, and in related drawings, except for those services and materials specifically noted.

B. Include auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, signal isolators, software, and drivers to interface with existing equipment or equipment provided by others under other Sections of these specifications, whether indicated on the Drawings or not.

C. All equipment and installations shall satisfy applicable Federal, State and local codes. Refer to Electrical drawings for area classifications for Class and /Division ratings.

D. Use the equipment, instrument, and loop numbering scheme indicated on the Drawings and in the specifications in the development of the submittals. Do not deviate from or modify the numbering scheme.

E. The PCSS shall provide all work required to provide a fully functioning control system at the new Chemical Systems Feed Building as described below. PCSS Shall:
   1. Provide a new PLC-CHEM control panel as shown on the Drawings
   2. Provide new fill station control panels and local control panels as shown on the Drawings
   3. Provide a new fiber optic patch panel (FOPP) and media converter in the CS-2 building as shown on the Drawings
   4. Provide a new UPS in the Tower Control House (TCH) Building to power instrumentation and new input cards to PLC-TCH as shown on the Drawings
   5. Provide new chlorine, pH, and phosphate analyzers in the Tower Control House as shown on the Drawings.
   6. Reconfigure existing HMI system in the Operations Center to include the new chemical system feed building monitoring and control.
   7. Reconfigure the plant existing historical collection and alarm notification system to include the new chemical system feed building.

F. Related Requirements:
   1. Section 4062XX - Sections for Computer System Hardware.
   2. Section 4063XX - Sections for Control System Equipment.

3. Section 4066XX - Sections for Network and Communication Equipment.
4. Section 4067XX - Sections for Control System Equipment Panels and Racks.

1.3 DEFINITIONS

A. PCSS – Process Control System Supplier.

B. AESS - Applications Engineering System Supplier.

C. “Section 4062XX - Sections for Computer System Hardware” – The XX in the number indicates all spec sections starting with the first 4 numbers (indicating a category described in the accompanying text) are included in the reference.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project site

B. Conduct a project kickoff coordination meeting within two weeks after submitting the Project Plan. The purpose of the meeting is to discuss the PCSS's Project Plan, to summarize the PCSS's understanding of the project; discuss any proposed substitutions or alternatives; schedule testing and delivery deadline dates; provide a forum to coordinate hardware and software related issues; and request any additional information required from the Owner. The meeting will last up to 4 hours.

C. Conduct a submittal review coordination meeting after the Hardware, Panel Drawing, and Loop Drawing Submittal package has been reviewed by the Engineer and returned to the PCSS. The purpose of this meeting is to review comments made on the submittal package; to refine scheduled deadline dates; coordinate equipment installation activities; and provide a forum for any further required coordination between the PCSS and AESS. The meeting will last up to 4 hours.

D. Monthly on-site or conference call coordination meetings with Engineer, Contractor, Vendors, and AESS as required prior to any field start-up or activity testing begins.

E. Schedule the mandatory coordination meetings as described herein. Hold the meetings at the Owner's designated location and include attendance by the Owner, the Engineer, the Contractor, the PCSS's Project Engineer, and the AESS Project Engineer, if applicable. Other Division specifications may require additional meetings. Prepare and distribute an agenda for this meeting a minimum of one week before the scheduled meeting date. Schedule the meeting for a minimum of one week before the requested meeting date.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of equipment, control panels, and instrumentation as specified herein.
   4. Include diagrams for power, signal, and control wiring.

C. Qualifications Submittal:
   1. For non-listed PCSS', submit, within 15 calendar days after Notice to Proceed, detailed information on staff and organization to indicate compliance with the Quality Assurance requirements of this Section. The Qualifications submittal is required to be submitted and approved before any further submittals will be accepted. Failure to meet the minimum requirements shall be grounds for rejection as a PCSS. The Qualifications Submittal shall, as a minimum, contain the following:
      a. Copies of ISA CCST Level 1 certificates for all field technicians or resumes demonstrating field experience.
      b. Notarized statement from the firm's financial institution demonstrating ability for the firm to meet the obligations necessary for the performance of the work.
      c. Copy of UL-508 certificate for panel fabrication facilities.
      d. Project references for water or wastewater projects as defined in the "Quality Assurance" paragraphs.
      e. Documentation to demonstrate the ability to complete this project including: resumes of key staff, financial capacities, details on engineering, design, fabrication, and field service capacity, and location of staff responsible for responding to the site within four hours to resolve startup issues.

D. Project Plan, Deviation List, and Schedule Submittal:
   1. Submit, within 30 calendar days after Notice to Proceed, a Project plan. The Project Plan is required to be submitted and approved before further submittals shall be accepted. The Project Plan shall contain the following:
      a. Overview of the proposed control system describing the understanding of the project work, a preliminary system architecture drawing, interfaces to other systems, schedule, startup, and coordination. Include a general discussion of startup, approach to testing and training, and other tasks as required by these specifications.
      b. Preliminary list of all HMI software, PLC software, and PLC hardware, including version numbers, solely to determine compliance with the requirements of the Contract Documents prior to beginning development of system programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSS of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved is not allowed without Engineer approval.
      c. Project personnel and organization including the PCSS project manager, project engineer, and lead project technicians. Include resumes of each these individuals and specify in writing their commitment to this project. These do not need to be submitted again if already submitted in the Qualification submittal.

d. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of panel fabrication drawings and I/O wiring diagrams**.**

2. Exceptions to the Specifications or Drawings shall be clearly defined in a Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. If no exceptions are taken to the specifications or drawings the PCSS shall make a statement as such. If there is no statement by the PCSS, then it is acknowledged that no exceptions are taken.
3. The PCSS must coordinate their work with the General Contractor's overall schedule and is responsible for ensuring a schedule is included in this submittal that incorporates all PCSS milestones including but not limited to the following:
   a. Schedule for all subsequent project submittals. Include the time required for Contractor submittal preparation, Engineer's review time, and a minimum of two complete review cycles.
   b. Proposed dates for all project coordination meetings.
   c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
   d. Software purchasing and configuration (following approval of related submittals).
   e. Shipment of instrument and control system equipment.
   f. Installation of instrument and control system equipment.
   g. Testing: Schedule for all testing.
   h. Schedule for system cutover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI server/workstation provided under this Contract.
   i. Schedule for all training including submittal and approval of O&M manuals, factory training, and site training.
      Listing of all major graphics and PLC programs intended to be created or modified for this project. Indicate if graphic or program is new or existing.
4. Component and Wiring Identification and Tagging Plan
   a. All components provided by PCSS require a tag, label, or nameplate. Review specifications and drawings and adhere to the established conventions.
   b. Provide detailed information so Engineer can review the following characteristics for each type of tag, label, or nameplate for the different types of components provided above:
      1) Size or range of size of the tag, label or nameplate.
      2) Font style.
      3) Material.
      4) Color(s).

E. Input/Output (I/O) List Submittal:
1. Submit, within 45 days after Notice to Proceed, a complete system Input/Output (I/O) address list for equipment connected to the control system under this Contract.
2. I/O list shall be based on the P&ID's, the Drawings, the design I/O list (if included), and requirements in the Specifications.
3. The I/O list shall be submitted in both a Microsoft Excel readable electronic file format and an 8-1/2 inch by 11-inch hard copy.
4. The I/O list shall reflect all active and spare I/O points. Add points to accommodate spare I/O as required in the specifications.

5. The I/O list shall be arranged such that each control panel has a dedicated worksheet. At a minimum, I/O worksheet shall include the following information:
    a. TAG NUMBER(S): As indicated on the Drawings, the identifier assigned to a device that performs a function in the control system. As part of this information, the loop number of the tag shall be broken out to allow for sorting by loop.
    b. DESCRIPTION: A description of the function of the device (text that includes signal source, control function, etc.) Include the text "Spare Points" for all I/O module points that are not connected to equipment.
    c. PHYSICAL LOCATION: The Control Panel designation of where the I/O point is wired to.
    d. PHYSICAL POINT ADDRESS: Rack, Slot, and Point (or Channel) assignment for each I/O point.
    e. I/O TYPE: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO - Pulse Output.
    f. RANGE/STATE: The range in engineering units corresponding to an analog 4-20 mA signal, or, the state at which the value of the discrete points are "1."
    g. ENGINEERING UNITS: The engineering units associated with the Analog I/O.
    h. ALARM LIMITS: Include alarm limits based on the control descriptions and the Drawings.
    i. P&ID - the P&ID or drawing where the I/O point appears on. Mark as "NA" (Not Applicable) if the I/O point is derived from a specification requirement and is not on the P&IDs.
    j. LOGICAL POINT ADDRESS: I/O address of each point
    k. EXISTING or NEW I/O POINT: Indicate if point is existing (E) or new (N).
    l. CONDITION OF EXISTING SIGNAL: Condition of existing I/O signals shall be noted as functional (F) if working properly or if not functioning (NF) with issue described.
6. The I/O list shall be sorted in order by:
    a. Physical location.
    b. I/O Type.
    c. Loop Number.
    d. Device Tag.
7. Once the I/O list is approved, the PLC I/O addresses shall not be modified without approval by the Engineer.

F. Field Instruments Submittal:
1. Refer to the Instruments section for submittal requirements.

G. Control System Architecture, Hardware, and Software Packages Submittal:
1. Refer to the sections below for equipment required as part of the Hardware and Software Packages submittal:
    a. Section 4062XX - Sections for Computer System Hardware.
    b. Section 4063XX - Sections for Control System Equipment.
    c. Section 4066XX - Sections for Network and Communication Equipment.
    d. Section 4067XX - Sections for Control System Equipment Panels and Racks.
    e. Section 4068XX - Sections for Process Control Software.
2. For each hardware and software packages component specified in the sections above, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001 (updated in 2007), general data sheet; however, other formats will be acceptable provided they contain all required information.

3. Complete system architecture drawing(s) showing in schematic form showing the interconnections between major hardware components including, control panels, computers, networking equipment, control panels with PLC systems and I/O modules, local operator interfaces, process equipment vendor panels with PLCs, and networked peripherals such as power monitors, security cameras, etc. The PCSS is required to provide unique network architecture drawings for the SCADA network.
4. The system architecture drawing(s) shall be developed in accordance with the following information and guidelines at a minimum:
    a. Show power connections to each piece of equipment or grouping of equipment with voltage and power sources noted such as 120VAC UPS battery, 24VDC battery, or 120VAC from LP (lighting panel). Indicate specific UPS number or circuit number whenever possible.
    b. All communication cable types should be uniquely identified with a specific linetype and cable characteristics clearly indicated in a key or legend located on drawing(s). For example, 50/125 micron multimode mode fiber, or CAT-6E Ethernet copper cabling. Any multiconductor communication cables will be clearly labeled above each individual communication with a note added to drawing that states if no quantity exists above a linetype, there is only one communication cable between devices. If a multi-conductor cable has multiple colors, legend shall clearly indicate which colors are used for which networks (i.e., a multi-pair fiber optic cable used for dedicated networks such as SCADA, Electrical, Security, HVAC, etc.)
    c. All communication cables need to be assigned a unique cable identification label and shown in either a table or above the communication line.
    d. Network protocols shall be clearly identified for each communication path or for system and indicated in a key or legend as appropriate. Examples are Allen-Bradley EtherNet/IP, Modbus TCP/IP, or DNP3.
    e. Any device that has multiple ports or connection points, shall clearly indicate which port or connection number the communication cable is terminating at. For multiple devices, this could be shown once in a key or legend and noted on architecture as appropriate.
    f. For each PLC control panel or network communication enclosure provided by PCSS, the architecture drawing shall clearly reference other drawings provided by the PCSS for detailed panel wiring diagrams with a note near that PLC panel or communication enclosure indicating referenced drawing numbers. A placeholder is acceptable at the time of submission if these drawings are to be submitted at a later date.
    g. Use symbology and/or icons whenever possible to represent a device and differentiate between devices that are different form factors (i.e. tower computer vs. desktop computer vs. rack mounted). Vendor CAD libraries are preferred for symbols.
    h. The intent of this specification requirement is to develop a diagram that will allow a qualified technician to interconnect all equipment without having to refer to additional manuals or literature.
    i. Sheet size shall be 11"x17" minimum and using more than one sheet is acceptable with a logical breakout between sheets (i.e., head end on one sheet and plant control system on another). Line continuations must between drawings must be clearly identified.
5. Provide a software schedule or spreadsheet for project which clearly indicates which software packages and operating systems are loaded onto which computers and servers.

Refer to Section 406893 – Computer Operating System Software for preliminary schedule prepared by Engineer as well as additional requirements.

H. Panel Layout Drawings and Wiring Diagrams Submittal:
1. Panel Layout Drawings: Submit Drawings for all panels specified. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be 11"x17" in size. At a minimum, the panel drawings shall include the following:
   a. A legend sheet clearly indicating all symbols used on drawings and with voltage, color and size of each wire clearly indicated and in accordance with requirements of Section 406733 – Panel Wiring.
   b. Interior and exterior panel elevation drawings to scale.
   c. Nameplate schedule.
   d. Conduit access locations.
   e. Panel construction details.
   f. Cabinet assembly and layout drawings to scale. Assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. Bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify all components of the assembly by manufacturer and model number.
   g. Fabrication and painting specifications including color (or color samples).
   h. Construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.
   i. For every control panel, heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.
   j. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. Costs associated with obtaining the UL seal and any inspections shall be borne by Contractor.
2. Wiring Diagrams Submittal:
   a. Where direct hardwired interfaces exist between the PCSS control panels and vendor provided control panels furnished under other Divisions, Contractor shall provide to PCSS approved submittals in order for PCSS to provide complete wiring diagrams showing all wiring connections in the I/O system. This includes but is not limited to terminal block numbering, relay contact information, instruments, equipment, and control panel names. These drawings shall be included in Final O&M submittal. Leaving this information blank on Final Documentation drawings is not acceptable.
   b. Panel wiring diagrams depicting wiring within and on the panel as well as connections to external devices. If ISA Loop Wiring Diagrams are specified below, equipment external to the control panel and related external connections do not need to be shown on the Panel Wiring Diagrams. Panel wiring diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering. Field device wiring shall include the device ISA-tag and a unique numeric identifier. Diagrams shall identify all device terminal points that the system connects to, including terminal points where I/O wiring lands on

equipment not supplied by the PCSS. Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the PCSS and approved by the Engineer. I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme. Panel drawings shall be 11" x 17" in size.

c. ISA Loop Wiring Diagrams: Not required.

I. Human Machine/Operator Interface Submittals:
1. Refer to Section 406863 – Configuration of HMI Software for specific submittal requirements.

J. Controller Program Submittal:
1. Refer to Section 406866 – Configuration of Controller Software for specific submittal requirements.

K. Testing Plan Submittals:
1. Refer to Section 406121- Process Control System Testing for specific testing submittal requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For any named PCSS, submit a statement on company letterhead indicating that the requirements in the “Quality Assurance” paragraph below are met by the firm.

B. Product Test Reports: Refer to individual instrument, component or hardware specifications for specific requirements.

C. Evaluation Reports: Refer to individual instrument, component or hardware specifications for specific requirements.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For all PCSS supplied hardware to include in to include in operation and maintenance manuals.
1. Submit in accordance with Section 017823 - Operation and Maintenance Data.
2. The operations and maintenance manuals shall, at a minimum, contain the following information:
a. Table of Contents:
1) A Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.
b. Instrument and Equipment Lists:
1) The following lists shall be developed in Microsoft Excel format:
a) An instrument list or spreadsheet for all instruments supplied including tag number, description, specification section and paragraph number, manufacturer, model number, calibrated range, location, manufacturer phone number, local supplier name, local supplier

phone number, completion year replacement cost, and any other pertinent data.

b) An equipment list or spreadsheet for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

c. Equipment Operations and Maintenance Information:

1) ISA-TR20.00.01-2001(updated in 2007) data sheets shall be provided for all field instruments. For non-field instrumentation devices, provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number, Location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001(updated in 2007), general data sheet; however, other formats will be acceptable provided they contain all required information.

2) Vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly indicated with arrows or circles. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages or sections that do not apply at all to the specific model supplied shall be removed.

3) Provide the record documentation of the system audit and completed test forms with sign-offs as specified in Section 406121- Testing.

4) Include instrument/equipment calibration and configuration forms developed as specified in Section 406121- Testing.

d. As-Built Drawings:

1) Complete as-built drawings, including all drawings and diagrams specified in this section under the "Submittals" section. These drawings shall include all termination points on all equipment the system is connected to, including terminal points of equipment not supplied by the PCSS. Provide electronic files for all drawings produced. Drawings shall be in Adobe Acrobat format.

2) As built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated in this documentation.

B. Operations and Maintenance Data - Software Maintenance Manual

1. Include these manuals as part of Section 406100 "Final System Documentation". This required information is in addition to all requirements of Section 406100.
2. Software Listings and Databases- Submit hard copies of the same information required in the "Controller Program Submittal" except include files updated to reflect the as built system. Include PDF versions of these files on the DVDs specified below.
3. PID Loop Tuning Parameters - Submit annotated chart recorder traces or computer system trend screen printouts showing tuned control loop response to plus and minus 40 percent of full span step changes of loop setpoint for each individual loop. For cascade loops, submit charts showing response of the secondary loop with secondary setpoint on manual and also response of the entire cascade control loop in automatic mode. Include a description of tuning methodology used.

4. Supply hardcopies of configuration information for the HMI systems, reporting systems, Historian Systems, and any other programs developed under this Contract.
5. Machine Readable Documentation - Provide two sets of as built software documentation on DVDs or USB thumb drives in original electronic format for all PLC, HMI systems, reporting systems, Historian Systems, and any other programs developed under this Contract. All changes made during or after testing, start-up, and commissioning shall be incorporated.
6. Include final version of the system standards and conventions manual reflecting as-programmed conditions.
7. System Configuration Section:
    a. A printout (or screen capture) of all configuration screens for every device requiring PCSS configuration. This includes, but is not limited to, MES', PLC processors, EtherNet/IP and any other communication modules, and HMI software.

C. Operations and Maintenance Data - Operators' Manual:
1. Provide Operator's Manuals prior to final acceptance of the system.
2. This manual shall be separately bound and shall contain all information necessary for the operator to monitor and control the plant from the control system. The manuals shall be written in non-technical terms and shall be organized for quick access to each detailed description of the operator's procedure. Manuals shall contain, but not be limited to, the following information:
    a. A comprehensive table of contents of the manual.
    b. A simple overview of the entire system indicating the function and purpose of major control system components described by area or building.
    c. A detailed description of the operation of the HMI and OIT including all appropriate displays. Including a screenshot of each HMI and OIT display screen and annotating each function in text is an acceptable format for presenting this information.
    d. Step-by-step procedures for starting up or shutting down critical component of the control system such as server or a control panel.
    e. Login / logout procedures for the operator interface system(s).
    f. Complete, step-by-step procedures for printing reports and entering manual data.
    g. Complete, step-by-step procedures for performing system or selected file backup and restoration including archiving historical data. Include recommended archiving schedule for historical data and/or frequency system performs an automatic back-up with a listing of all applications that are backed up or need to be backed up.
    h. Operational description for operating HMI computer equipment and peripherals including printers, CD-ROMs, removable bulk storage devices, UPS, etc. Description shall include procedures for typical maintenance and troubleshooting tasks.
    i. A complete glossary of terms and definition of acronyms.
    j. List of personnel to be contacted for warranty and emergency services, including name, address, telephone number, pager or cell phone number, fax number, and email address.

D. Software and Firmware Operational Documentation:
    a. Original Licensed Software:
        1) Submit original software licenses and keys for all software provided under this Contract. Submit original paper based and electronic documentation for all software provided. Submit license agreement information including serial numbers, license agreements, User Registration Numbers and related

information. All software provided under this Contract shall be licensed to the Owner at the time of purchase. Provide media in software sleeves within O&M manual.

a. Electronic O&M Information:
   1) In addition to the hard copy of O&M data, provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files, on DVD or USB thumb drive. Electronic documents shall be supplied in Adobe Acrobat format.
   2) Provide electronic files for all custom-developed manuals including training manuals. Text shall be supplied in both Microsoft Office format and Adobe Acrobat format.
   3) Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in Adobe Acrobat format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.
   4) Each computer system hardware device shall be backed up onto DVD or USB thumb drive after Substantial Completion and shall be turned over to the Owner.
   5) If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 800 by 600 pixels and shall include sound.

2. The cover and edge of each volume shall contain the information as specified in Section 017823 - Operation and Maintenance Data.

1.8 MAINTENANCE MATERIAL SUBMITTAL

A. Furnish extra materials from the same product run**,** that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Refer to individual specification sections in Division 406121 through 407833 for spare equipment requirements and provide one comprehensive spare parts submittal for project

B. All spare parts shall be packed in individual cartons and labeled with indelible markings clearly indicating component(s) inside. Complete ordering information paperwork including manufacturer's contact information (address and phone number), part name, part number, equipment name and tag number(s) for which the part is to be used (if applicable) shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the Owner or Engineer.

1.9 QUALITY ASSURANCE

A. Fabricator Qualifications: Control panel fabricator shall hold a valid UL-508 certification for their panel fabrication facility.

B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

C. The PCSS as a minimum shall be responsible for the technical supervision of the installation by providing on site supervision to the installers of the various components.

D. The Process Control System Supplier (PCSS) shall be a "systems integrator" regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry. For the purposes of this Specification Section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
   1. Employs personnel on this project who have successfully completed ISA or manufacturers training courses on general process instrumentation and configuration and implementation of the specific programmable controllers, computers, and software proposed for this project. Key personnel shall hold ISA CCST Level 1 certification or have a minimum of 10 years of verifiable plant startup experience. Key personnel shall include, as a minimum, the lead field technician.
   2. Has successfully completed work of similar or greater complexity on at least three previous projects within the last five years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the PCSS. Potential references shall be for projects where the PCSS's contract was of similar size to this project.
   3. Has been actively engaged in the type of work specified in this Section for a minimum of five years.

E. The PCSS shall maintain a permanent, fully staffed and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, and testing the systems specified herein. At a minimum, the PCSS shall be capable of responding to on-site problems within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.

F. Being listed in this specification does not relieve any potential PCSS from meeting the qualifications specified in this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 016000 "Product Requirements" for delivery, storage, and handling requirements.

1.11 FIELD CONDITIONS

A. Environmental Requirements. Refer to Electrical Drawings for specific environmental and hazardous area classifications.

B. Elevation: Equipment shall be designed to operate at the project ground elevation.

C. Temperature:
   1. Outdoor areas' equipment shall operate between -30 to 50 C degrees ambient.
   2. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.
   3. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.
   4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.

5. Relative Humidity. Air-conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 5 to 100 percent relative, condensing humidity.

D. None of the control system equipment located in the control room shall be shipped to the site until the control room areas comply with specified ambient temperature and humidity and free of dust and debris.

1.12 WARRANTY

1. Warranty Period: 1 year from date of Substantial Completion unless noted otherwise in individual specification sections.

PART 2 - PRODUCTS

2.1 GENERAL

A. Electrical Requirements for Control System:
1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.
2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).
3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero-based signals will be allowed.
4. All switches shall have double-pole, double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.
5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired in a fail-safe manner as shown on the P&IDs. A fail-safe condition is when an open circuit generates an alarm state (i.e. contact opens).
6. Materials and equipment shall be UL approved whenever such approved equipment and materials are available.
7. All equipment furnished shall be designed and constructed so that in the event of power interruption, the systems specified herein shall go through an orderly shutdown with no loss of memory and shall resume normal operation without manual resetting when power is restored, unless otherwise noted.
8. Surge protection requirements for control system power, signal, and communication lines are specified in Section 407856 – Isolators, Intrinsically Safe Barriers, and Surge Suppressors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 GENERAL INSTALLATION

A. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

B. Provide sunshades for equipment mounted outdoors in direct sunlight. Include sunshades standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North to minimize the impact of glare and ultraviolet exposure on digital readouts.

3.3 IDENTIFICATION

A. Provide identification system for all PCSS provided hardware, instrumentation, and communication cabling. Provide details as specified in “Project Plan”.

3.4 FIELD QUALITY CONTROL

A. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Refer to Section 406121 - Process Control System Testing.

B. Refer to Section 406126 - Process Control System Training.

C. Engage a factory-authorized service representative to perform startup service as specified in individual hardware and instrument specifications.

D. Bi-weekly on-site coordination meetings with Engineer, Contractor, and others as required during active construction period.

3.6 SOFTWARE SERVICE AGREEMENT

A. Not Required.

END OF SECTION 406100

Appendix A - I&C IO List

S.No.	P&ID	I/O POINT TAG	DESCRIPTION	FUNCTION	POINT TYPE	PLC	RACK	SLOT	CHANNEL
1	I-4	LAH-1310	Sodium Hypochlorite Containment Sump High Level	Alarm	DI	PLC-CHEM			
2	I-4	YFI-1300	Sodium Hypochlorite Containment Sump Pump Fault	Alarm	DI	PLC-CHEM			
3	I-4	YRI-1300	Sodium Hypochlorite Containment Sump Pump Running	Status	DI	PLC-CHEM			
4	I-4	XA-1305	Sodium Hypochlorite Area General HVAC Alarm	Alarm	DI	PLC-CHEM			
5	I-4	YCI-1015	Sodium Hypochlorite Bulk Storage Tank 1 Fill Valve In Auto	Status	DI	PLC-CHEM			
6	I-4	ZSO-1015	Sodium Hypochlorite Bulk Storage Tank 1 Fill Valve Opened	Status	DI	PLC-CHEM			
7	I-4	ZSC-1015	Sodium Hypochlorite Bulk Storage Tank 1 Fill Valve Closed	Status	DI	PLC-CHEM			
8	I-4	HS-1015A	Sodium Hypochlorite Bulk Storage Tank 1 Fill Valve Open Command	Command	DO	PLC-CHEM			
9	I-4	HS-1015B	Sodium Hypochlorite Bulk Storage Tank 1 Fill Valve Close Command	Command	DO	PLC-CHEM			
10	I-4	XA-1000	Outdoor Beacon Alarm Light	Command	DO	PLC-CHEM			
11	I-4	YCI-1025	Sodium Hypochlorite Bulk Storage Tank 2 Fill Valve In Auto	Status	DI	PLC-CHEM			
12	I-4	ZSO-1025	Sodium Hypochlorite Bulk Storage Tank 2 Fill Valve Opened	Status	DI	PLC-CHEM			
13	I-4	ZSC-1025	Sodium Hypochlorite Bulk Storage Tank 2 Fill Valve Closed	Status	DI	PLC-CHEM			
14	I-4	HS-1025A	Sodium Hypochlorite Bulk Storage Tank 2 Fill Valve Open Command	Command	DO	PLC-CHEM			
15	I-4	HS-1025B	Sodium Hypochlorite Bulk Storage Tank 2 Fill Valve Close Command	Command	DO	PLC-CHEM			
16	I-4	YCI-1103	Sodium Hypochlorite Bulk Storage Tank 1 Discharge Valve In Auto	Status	DI	PLC-CHEM			
17	I-4	ZSO-1103	Sodium Hypochlorite Bulk Storage Tank 1 Discharge Valve Opened	Status	DI	PLC-CHEM			
18	I-4	ZSC-1103	Sodium Hypochlorite Bulk Storage Tank 1 Discharge Valve Closed	Status	DI	PLC-CHEM			
19	I-4	HS-1103A	Sodium Hypochlorite Bulk Storage Tank 1 Discharge Valve Open Command	Command	DO	PLC-CHEM			
20	I-4	HS-1103B	Sodium Hypochlorite Bulk Storage Tank 1 Discharge Valve Close Command	Command	DO	PLC-CHEM			
21	I-4	YCI-1203	Sodium Hypochlorite Bulk Storage Tank 2 Discharge Valve In Auto	Status	DI	PLC-CHEM			
22	I-4	ZSO-1203	Sodium Hypochlorite Bulk Storage Tank 2 Discharge Valve Opened	Status	DI	PLC-CHEM			
23	I-4	ZSC-1203	Sodium Hypochlorite Bulk Storage Tank 2 Discharge Valve Closed	Status	DI	PLC-CHEM			
24	I-4	HS-1203A	Sodium Hypochlorite Bulk Storage Tank 2 Discharge Valve Open Command	Command	DO	PLC-CHEM			
25	I-4	HS-1203B	Sodium Hypochlorite Bulk Storage Tank 2 Discharge Valve Close Command	Command	DO	PLC-CHEM			
26	I-4	LI-1110	Sodium Hypochlorite Bulk Storage Tank 1 Level	Indication	AI	PLC-CHEM			
27	I-4	LAHH-1110	Sodium Hypochlorite Bulk Storage Tank 1 High High Level	Alarm	DI	PLC-CHEM			
28	I-4	LALL-1110	Sodium Hypochlorite Bulk Storage Tank 1 Low Low Level	Alarm	DI	PLC-CHEM			
29	I-4	LI-1120	Sodium Hypochlorite Bulk Storage Tank 2 Level	Indication	AI	PLC-CHEM			
30	I-4	LAHH-1120	Sodium Hypochlorite Bulk Storage Tank 2 High High Level	Alarm	DI	PLC-CHEM			
31	I-4	LALL-1120	Sodium Hypochlorite Bulk Storage Tank 2 Low Low Level	Alarm	DI	PLC-CHEM			

S.No.	P&ID	I/O POINT TAG	DESCRIPTION	FUNCTION	POINT TYPE	PLC	RACK	SLOT	CHANNEL
32	I-4	HS-1710	Sodium Hypochlorite Water valve Open/Close Command	Command	DO	PLC-CHEM			
33	I-4	YFI-1210	Sodium Hypochlorite Transfer Pump 1 Fault	Alarm	DI	PLC-CHEM			
34	I-4	YRI-1210	Sodium Hypochlorite Transfer Pump 1 Running	Status	DI	PLC-CHEM			
35	I-4	YFI-1220	Sodium Hypochlorite Transfer Pump 2 Fault	Alarm	DI	PLC-CHEM			
36	I-4	YRI-1220	Sodium Hypochlorite Transfer Pump 2 Running	Status	DI	PLC-CHEM			
37	I-4	FAH-1020	Sodium Hypochlorite Area Emergency Shower And Eyewash Unit High Flow	Alarm	DI	PLC-CHEM			
38	I-4	XA-1270A	FACP Aalarm	Alarm	DI	PLC-CHEM			
39	I-4	XA-1270B	FACP Trouble	Alarm	DI	PLC-CHEM			
40	I-4	JA-1275	UPS on Battery	Status	DI	PLC-CHEM			
41	I-4	XA-1275	UPS Fault	Alarm	DI	PLC-CHEM			
42	I-4	JAL-1275	UPS Low Battery	Alarm	DI	PLC-CHEM			
43	I-4	YI-1275	UPS on Maintenance Bypass	Alarm	DI	PLC-CHEM			
44	I-4	XA-1125	Sodium Hypochlorite Fill Panel Intrusion	Alarm	DI	PLC-CHEM			
45	I-4	XA-1225	Sodium Hypochlorite Local Control Panel Intrusion	Alarm	DI	PLC-CHEM			
46	I-4	XA-1325	Chemical Building Control Panel Intrusion	Alarm	DI	PLC-CHEM			
47	I-4	LI-1500	Sodium Hypochlorite Day Tank Level	Indication	AO	PLC-CHEM			
48	I-4	LALL-1500	Sodium Hypochlorite Day Tank Low-Low Level	Alarm	DO	PLC-CHEM			
49	I-5	WI-1500	Sodium Hypochlorite Day Tank Weight	Indication	AI	PLC-CHEM			
50	I-5	LAHH-1500	Sodium Hypochlorite Day Tank High High Level	Alarm	DI	PLC-CHEM			
51	I-5	XA-1610	Sodium Hypochlorite Metering Pump 1 Leak	Status	DI	PLC-CHEM			
52	I-5	YCI-1610	Sodium Hypochlorite Metering Pump 1 In Auto	Status	DI	PLC-CHEM			
53	I-5	YRI-1610	Sodium Hypochlorite Metering Pump 1 Running	Status	DI	PLC-CHEM			
54	I-5	HSS-1610	Sodium Hypochlorite Metering Pump 1 Start/Stop Command	Command	DO	PLC-CHEM			
55	I-5	SI-1610	Sodium Hypochlorite Metering Pump 1 Speed Feedback	Indication	AI	PLC-CHEM			
56	I-5	SC-1610	Sodium Hypochlorite Metering Pump 1 Speed Setpoint	Command	AO	PLC-CHEM			
57	I-5	YFI-1610	Sodium Hypochlorite Metering Pump 1 VFD Fault	Alarm	DI	PLC-CHEM			
58	I-5	PAH-1610	Sodium Hypochlorite Metering Pump 1 Discharge Pressure High	Alarm	DI	PLC-CHEM			
59	I-5	XA-1620	Sodium Hypochlorite Metering Pump 2 Leak	Status	DI	PLC-CHEM			
60	I-5	YCI-1620	Sodium Hypochlorite Metering Pump 2 In Auto	Status	DI	PLC-CHEM			
61	I-5	YRI-1620	Sodium Hypochlorite Metering Pump 2 Running	Status	DI	PLC-CHEM			
62	I-5	HSS-1620	Sodium Hypochlorite Metering Pump 2 Start/Stop Command	Command	DO	PLC-CHEM			

S.No.	P&ID	I/O POINT TAG	DESCRIPTION	FUNCTION	POINT TYPE	PLC	RACK	SLOT	CHANNEL
63	I-5	SI-1620	Sodium Hypochlorite Metering Pump 1 Speed Feedback	Indication	AI	PLC-CHEM			
64	I-5	SC-1620	Sodium Hypochlorite Metering Pump 2 Speed Setpoint	Command	AO	PLC-CHEM			
65	I-5	YFI-1620	Sodium Hypochlorite Metering Pump 2 VFD Fault	Alarm	DI	PLC-CHEM			
66	I-5	PAH-1620	Sodium Hypochlorite Metering Pump 2 Discharge Pressure High	Alarm	DI	PLC-CHEM			
67	I-5	FAL-1651	Sodium Hypochlorite Carrier Water Low Flow	Alarm	DI	PLC-CHEM			
68	I-6	LAH-2310	Caustic Soda Containment Sump High Level	Alarm	DI	PLC-CHEM			
69	I-6	YFI-2300	Caustic Soda Sump Pump Fault	Alarm	DI	PLC-CHEM			
70	I-6	YRI-2300	Caustic Soda Sump Pump Running	Status	DI	PLC-CHEM			
71	I-6	LI-2100	Caustic Soda Bulk Storage Tank Level	Indication	AI	PLC-CHEM			
72	I-6	LALL-2100	Caustic Soda Bulk Storage Tank Low Low Level	Alarm	DI	PLC-CHEM			
73	I-6	LAHH-2100	Caustic Soda Bulk Storage Tank High High Level	Alarm	DI	PLC-CHEM			
74	I-6	YFI-2210	Caustic Soda Transfer Pump 1 Fault	Alarm	DI	PLC-CHEM			
75	I-6	YRI-2210	Caustic Soda Transfer Pump 1 Running	Status	DI	PLC-CHEM			
76	I-6	YFI-2220	Caustic Soda Transfer Pump 2 Fault	Alarm	DI	PLC-CHEM			
77	I-6	YRI-2220	Caustic Soda Transfer Pump 2 Running	Status	DI	PLC-CHEM			
78	I-6	HS-2710	Caustic Soda Water Valve Open/Close Command	Command	DO	PLC-CHEM			
79	I-6	FAH-2020	Caustic Soda Area Emergency Shower And Eyewash Unit High Flow	Alarm	DI	PLC-CHEM			
80	I-6	XA-2125	Caustic Soda Fill Panel Intrusion	Alarm	DI	PLC-CHEM			
81	I-6	XA-2225	Caustic Soda Local Control Panel Intrusion	Alarm	DI	PLC-CHEM			
82	I-6	LI-2500	Caustic Soda Day Tank Level	Indication	AO	PLC-CHEM			
83	I-6	LALL-2500	Caustic Soda Day Tank Low-Low Level	Alarm	DO	PLC-CHEM			
84	I-7	WI-2500	Caustic Soda Day Tank Weight	Indication	AI	PLC-CHEM			
85	I-7	LAHH-2500	Caustic Soda Day Tank High High Level	Alarm	DI	PLC-CHEM			
86	I-7	XA-2610	Caustic Soda Metering Pump 1 Leak	Status	DI	PLC-CHEM			
87	I-7	YCI-2610	Caustic Soda Metering Pump 1 In Auto	Status	DI	PLC-CHEM			
88	I-7	YRI-2610	Caustic Soda Metering Pump 1 Running	Status	DI	PLC-CHEM			
89	I-7	HSS-2610	Caustic Soda Metering Pump 1 Start/Stop Command	Command	DO	PLC-CHEM			
90	I-7	SI-2610	Caustic Soda Metering Pump 1 Speed Feedback	Indication	AI	PLC-CHEM			
91	I-7	SC-2610	Caustic Soda Metering Pump 1 Speed Setpoint	Command	AO	PLC-CHEM			
92	I-7	YFI-2610	Caustic Soda Metering Pump 1 VFD Fault	Alarm	DI	PLC-CHEM			
93	I-7	PAH-2610	Caustic Soda Metering Pump 1 Discharge Pressure High	Alarm	DI	PLC-CHEM			

S.No.	P&ID	I/O POINT TAG	DESCRIPTION	FUNCTION	POINT TYPE	PLC	RACK	SLOT	CHANNEL
94	I-7	XA-2620	Caustic Soda Metering Pump 2 Leak	Status	DI	PLC-CHEM			
95	I-7	YCI-2620	Caustic Soda Metering Pump 2 In Auto	Status	DI	PLC-CHEM			
96	I-7	YRI-2620	Caustic Soda Metering Pump 2 Running	Status	DI	PLC-CHEM			
97	I-7	HSS-2620	Caustic Soda Metering Pump 2 Start/Stop Command	Command	DO	PLC-CHEM			
98	I-7	SI-2620	Caustic Soda Metering Pump 2 Speed Feedback	Indication	AI	PLC-CHEM			
99	I-7	SC-2620	Caustic Soda Metering Pump 2 Speed Setpoint	Command	AO	PLC-CHEM			
100	I-7	YFI-2620	Caustic Soda Metering Pump 2 VFD Fault	Alarm	DI	PLC-CHEM			
101	I-7	PAH-2620	Caustic Soda Metering Pump 2 Discharge Pressure High	Alarm	DI	PLC-CHEM			
102	I-7	FAL-2651	Caustic Soda Carrier Water Low Flow	Alarm	DI	PLC-CHEM			
103	I-8	LAH-3310	Corrosion Inhibitor Containment Sump High Level	Alarm	DI	PLC-CHEM			
104	I-8	YFI-3300	Corrosion Inhibitor Sump Pump Fault	Alarm	DI	PLC-CHEM			
105	I-8	YRI-3300	Corrosion Inhibitor Sump Pump Running	Status	DI	PLC-CHEM			
106	I-8	LI-3100	Corrosion Inhibitor Bulk Storage Tank Level	Indication	AI	PLC-CHEM			
107	I-8	LALL-3100	Corrosion Inhibitor Bulk Storage Tank Low Low Level	Alarm	DI	PLC-CHEM			
108	I-8	LAHH-3100	Corrosion Inhibitor Bulk Storage Tank High High Level	Alarm	DI	PLC-CHEM			
109	I-8	YFI-3210	Corrosion Inhibitor Transfer Pump 1 Fault	Alarm	DI	PLC-CHEM			
110	I-8	YRI-3210	Corrosion Inhibitor Transfer Pump 1 Running	Status	DI	PLC-CHEM			
111	I-8	YFI-3220	Corrosion Inhibitor Transfer Pump 2 Fault	Alarm	DI	PLC-CHEM			
112	I-8	YRI-3220	Corrosion Inhibitor Transfer Pump 2 Running	Status	DI	PLC-CHEM			
113	I-8	HS-3710	Corrosion Inhibitor Water Valve Open/Close Command	Command	DO	PLC-CHEM			
114	I-8	FAH-3005	Tank Fill Area Emergency Shower And Eyewash Unit High Flow	Alarm	DI	PLC-CHEM			
115	I-8	FAH-3010	Corrosion Inhibitor Area Emergency Shower And Eyewash Unit High Flow	Alarm	DI	PLC-CHEM			
116	I-8	XA-3125	Corrosion Inhibitor Fill Panel Intrusion	Alarm	DI	PLC-CHEM			
117	I-8	XA-3225	Corrosion Inhibitor Local Control Panel Intrusion	Alarm	DI	PLC-CHEM			
118	I-8	LI-3500	Corrosion Inhibitor Day Tank Level	Indication	AO	PLC-CHEM			
119	I-8	LALL-3500	Corrosion Inhibitor Day Tank Low-Low Level	Alarm	DO	PLC-CHEM			
120	I-9	WI-3500	Corrosion Inhibitor Day Tank Weight	Indication	AI	PLC-CHEM			
121	I-9	LAHH-3500	Corrosion Inhibitor Day Tank High High Level	Alarm	DI	PLC-CHEM			
122	I-9	XA-3610	Corrosion Inhibitor Metering Pump 1 Leak	Status	DI	PLC-CHEM			
123	I-9	YCI-3610	Corrosion Inhibitor Metering Pump 1 In Auto	Status	DI	PLC-CHEM			
124	I-9	YRI-3610	Corrosion Inhibitor Metering Pump 1 Running	Status	DI	PLC-CHEM			

S.No.	P&ID	I/O POINT TAG	DESCRIPTION	FUNCTION	POINT TYPE	PLC	RACK	SLOT	CHANNEL
125	I-9	HSS-3610	Corrosion Inhibitor Metering Pump 1 Start/Stop Command	Command	DO	PLC-CHEM			
126	I-9	SI-3610	Corrosion Inhibitor Metering Pump 1 Speed Feedback	Indication	AI	PLC-CHEM			
127	I-9	SC-3610	Corrosion Inhibitor Metering Pump 1 Speed Setpoint	Command	AO	PLC-CHEM			
128	I-9	YFI-3610	Corrosion Inhibitor Metering Pump 1 VFD Fault	Alarm	DI	PLC-CHEM			
129	I-9	PAH-3610	Corrosion Inhibitor Metering Pump 1 Discharge Pressure High	Alarm	DI	PLC-CHEM			
130	I-9	XA-3620	Corrosion Inhibitor Metering Pump 2 Leak	Status	DI	PLC-CHEM			
131	I-9	YCI-3620	Corrosion Inhibitor Metering Pump 2 In Auto	Status	DI	PLC-CHEM			
132	I-9	YRI-3620	Corrosion Inhibitor Metering Pump 2 Running	Status	DI	PLC-CHEM			
133	I-9	HSS-3620	Corrosion Inhibitor Metering Pump 2 Start/Stop Command	Command	DO	PLC-CHEM			
134	I-9	SI-3620	Corrosion Inhibitor Metering Pump 2 Speed Feedback	Indication	AI	PLC-CHEM			
135	I-9	SC-3620	Corrosion Inhibitor Metering Pump 2 Speed Setpoint	Command	AO	PLC-CHEM			
136	I-9	YFI-3620	Corrosion Inhibitor Metering Pump 2 VFD Fault	Alarm	DI	PLC-CHEM			
137	I-9	PAH-3620	Corrosion Inhibitor Metering Pump 2 Discharge Pressure High	Alarm	DI	PLC-CHEM			
138	I-9	FAL-3651	Corrosion Inhibitor Carrier Water Low Flow	Alarm	DI	PLC-CHEM			
139	I-4	JA-0105	UPS on Battery	Status	DI	PLC-TCH			
140	I-4	XA-0105	UPS Fault	Alarm	DI	PLC-TCH			
141	I-4	JAL-0105	UPS Low Battery	Alarm	DI	PLC-TCH			
142	I-4	YI-0105	UPS on Maintenance Bypass	Alarm	DI	PLC-TCH			
143	I-10	AI-0101	Treated Water Residual Free Chlorine	Indication	AI	PLC-TCH			
144	I-10	AI-0102	Treated Water pH	Indication	AI	PLC-TCH			
145	I-10	AI-0103	Treated Water Phosphate level	Indication	AI	PLC-TCH			
146	I-10	FI-0302	Service Waer Flow to New Chemical Building	Indication	AI	PLC-CHEM			
147	I-10	XA-0630	Chemical Injection Double Containment Pipe Leak	Indication	DI	PLC-CS2			

Appendix B - I&C Instruments List

Flint, MI

Instrumentation Equipment Only (No valves)

Note: Column "G", "Range/Trip Point" will indicate the range of an analog instrument, i.e. 5 to 15 feet and the trip point will be the measurement that causes the switch to change states, i.e. 5 ft (for a level switch)

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S. No.	P&ID	DEVICE TAG	DESCRIPTION	INSTRUMENT TYPE	RANGE	LOW-LOW LEVEL ALARMING POINT	LOW LEVEL ALARMING POINT	HIGH LEVEL ALARMING POINT	HIGH-HIGH LEVEL ALARMING POINT	UNITS	POWER	PROVIDED BY	SPEC. REFERENCE	INSTALLATION DETAIL
1	I-4	LE/LT-1110	Sodium Hypochlorite Bulk Storage Tank 1 Level Transmitter	Radar level Transmitter	0-8' 11" OR 0-10' 6"	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407223	**A**
2	I-4	LI-1110	Sodium Hypochlorite Bulk Storage Tank 1 Level Indicator	Panel Meter (Wall mount)	0-100%	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407813	**A**
3	I-4	LSHH-1110	Sodium Hypochlorite Bulk Storage Tank 1 High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
4	I-4	LSLL-1110	Sodium Hypochlorite Bulk Storage Tank 1 Low-Low Level Switch	Ultrasonic Gap Switch		1.25				Feet	120 VAC - UPS	Div 40	407213	**C**
5	I-4	LE/LT-1120	Sodium Hypochlorite Bulk Storage Tank 2 Level Transmitter	Radar level Transmitter	0-8' 11" OR 0-10' 6"	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407223	**A**
6	I-4	LI-1120	Sodium Hypochlorite Bulk Storage Tank 2 Level Indicator	Panel Meter (Wall mount)	0-100%	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407813	**A**
7	I-4	LSHH-1120	Sodium Hypochlorite Bulk Storage Tank 2 High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
8	I-4	LSLL-1120	Sodium Hypochlorite Bulk Storage Tank 2 Low-Low Level Switch	Ultrasonic Gap Switch		1.25				Feet	120 VAC - UPS	Div 40	407213	**C**
9	I-4	LSH-1310	Sodium Hypochlorite Containment Sump High and Low Level Switch	Float Switch			.5	2		Feet	-	Div 40	407276	**D**
10	I-4	PI-1105	Sodium Hypochlorite Transfer Pump 1 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
11	I-4	PI-1205	Sodium Hypochlorite Transfer Pump 2 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
12	I-5	WE/WIT-1500	Sodium Hypochlorite Day Tank Weight Transmitter	Load Cell Weight Sensing Module	0-1150 OR 0-1200	TBD	TBD	TBD	TBD	Pounds	120 VAC - UPS	Div 40	407346	**B**
13	I-5	LSHH-1500	Sodium Hypochlorite Day Tank High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
14	I-5	FSL-1651	Sodium Hypochlorite Carrier Water Low Flow Switch	Vane Flow Switch			.5 - 1.5 gpm (field adjust)			GPM	-	Div 40	407179	**E**
15	I-6	LE/LT-2100	Caustic Soda Bulk Storage Tank Level Transmitter	Radar level Transmitter	0-13	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407223	**A**
16	I-6	LI-2100	Caustic Soda Bulk Storage Tank Level Indicator	Panel Meter (Wall mount)	0-100%	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407813	**A**
17	I-6	LSHH-2100	Caustic Soda Bulk Storage Tank High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
18	I-6	LSLL-2100	Caustic Soda Bulk Storage Tank Low-Low Level Switch	Ultrasonic Gap Switch		1.25				Feet	120 VAC - UPS	Div 40	407213	**C**
19	I-6	LSH-2310	Caustic Soda Containment Sump High and Low Level Switch	Float Switch			.5	2		Feet	-	Div 40	407276	**D**
20	I-6	PI-2210	Caustic Soda Transfer Pump 1 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
21	I-6	PI-2220	Caustic Soda Transfer Pump 2 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
22	I-7	WE/WIT-2500	Caustic Soda Day Tank Weight Transmitter	Load Cell Weight Sensing Module	0-2800	TBD	TBD	TBD	TBD	Pounds	120 VAC - UPS	Div 40	407346	**B**
23	I-7	LSHH-2500	Caustic Soda Day Tank High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
24	I-7	FSL-2651	Caustic Soda Carrier Water Low Flow Switch	Vane Flow Switch			.5 - 1.5 gpm (field adjust)			GPM	-	Div 40	407179	**E**
25	I-8	LE/LT-3100	Corrosion Inhibitor Bulk Storage Tank Level Transmitter	Radar level Transmitter	0-6 6" OR 0-7' 2"	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407223	**A**
26	I-8	LI-3100	Corrosion Inhibitor Bulk Storage Tank Level Indicator	Panel Meter (Wall mount)	0-100%	1.5	2	0.083 lower than LAHH	0.167 below overflow invert EL	Feet	120 VAC - UPS	Div 40	407813	**A**
27	I-8	LSHH-3100	Corrosion Inhibitor Bulk Storage Tank High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
28	I-8	LSLL-3100	Corrosion Inhibitor Bulk Storage Tank Low-Low Level Switch	Ultrasonic Gap Switch		1.25				Feet	120 VAC - UPS	Div 40	407213	**C**
29	I-8	LSH-3310	Corrosion Inhibitor Containment Sump High and Low Level Switch	Float Switch			.5	2		Feet	-	Div 40	407276	**D**
30	I-8	PI-3210	Corrosion Inhibitor Transfer Pump 1 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
31	I-8	PI-3220	Corrosion Inhibitor Transfer Pump 2 Discharge Pressure Indicator		0-30					PSI	N/A	Div 40	407313	**I**
32	I-9	WE/WIT-3500	Corrosion Inhibitor Day Tank Weight Transmitter	Load Cell Weight Sensing Module	0-785	TBD	TBD	TBD	TBD	Pounds	120 VAC - UPS	Div 40	407346	**B**
33	I-9	LSHH-3500	Corrosion Inhibitor Day Tank High-High Level Switch	Ultrasonic Gap Switch					Overflow Invert EL	Feet	120 VAC - UPS	Div 40	407213	**C**
34	I-9	FSL-3651	Corrosion Inhibitor Carrier Water Low Flow Switch	Vane Flow Switch			.5 - 1.5 gpm (field adjust)			GPM	-	Div 40	407179	**E**
35	I-10	AE/AIT-0101	Treated Water Residual Chlorine Analyzer		0-10 mg/L	TBD	TBD	TBD	4	mg/L	120 VAC - UPS	Div 40	407521	**F**
36	I-10	AE/AIT-0102	Treated Water pH Analyzer		0-14	TBD	TBD	TBD	TBD	-	120 VAC - UPS	Div 40	407513	**G**
37	I-10	AE/AIT-0103	Treated Water Phosphate Analyzer		0-10 mg/L	TBD	TBD	TBD	TBD	mg/L	120 VAC - UPS	Div 40	407569	**H**

SECTION 406121.20 - PROCESS CONTROL SYSTEM TESTING

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.

B. Refer to Section 406100.

C. Division 01 "Equipment Testing and Start-up" Section.

1.2 SUMMARY

A. Section includes testing requirements.

B. Furnish all labor, materials, equipment and incidentals required to complete the testing of all devices and systems furnished and installed as detailed on Drawings, and as specified herein.

C. Refer to Section 406100 for other general requirements.

1.3 ACTION SUBMITTALS

A. Refer to Section 406100.

B. Testing Submittals - Submit, in one submittal, the following testing related documents:
   1. Status signoff forms:
      a. Develop and submit project specific I/O Status and Automatic Control Strategy signoff forms to be used during factory and field testing to organize and track each loop's inspection, adjustment, calibration, configuration, and testing status and sign off. Include sign-off forms for each testing phase showing all loops.
         1) Example forms are shown in the Appendices.
         2) Separate forms for factory and field testing can be used, or they can be combined, at the discretion of the PCSS.
         3) Submit testing forms prior to start of testing.
   2. Testing Procedures:
      a. Submit detailed procedures proposed to be followed for each of the tests specified herein. The test procedures serve as the basis for the execution of the required tests to demonstrate that the system meets and functions as specified.
      b. Documents shall be structured in an orderly and easy to follow manner to facilitate an efficient and comprehensive test.
      c. Test procedures shall indicate all pre-testing setup requirements, all required test equipment, and simulation techniques to be used.
      d. Test procedures shall be structured in a cause and effect manner where the inputs are indicated, and the outputs are recorded.

e. Test procedures shall include the demonstration and validation under normal operating conditions and under various failure scenarios as specified in Contract Documents.
f. Testing may not start until all Testing Submittals have been approved.

C. Test Documentation:
1. Upon completion of each required test, document the test by submitting a copy of the signed off Testing Status forms. Testing shall not be considered complete until the signed-off forms have been submitted and approved. Submittals of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

1.4 COST OF TRAVEL

A. Scheduled tests will only be attended once by Engineer /Owner. If test is not successful, all subsequent tests will be performed at Contractor's expense. Reimburse Owner for all costs, including labor and expenses, invoiced by Engineer and incurred by Owner for subsequent retests.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING - GENERAL

A. Refer to Section 406100.

B. Results of all testing shall be tracked on a project specific status sign off form or similar document. PCSS shall be responsible for maintaining the sheet. Appendix of this Section has an example template for this sheet.

C. Tests the PCSS is required to perform are as follows:
1. Factory Testing:
a. Unwitnessed Factory Test (UFT).
b. Witnessed Factory Test (WFT).
2. Field Testing:
a. Operational Readiness Test (ORT).
b. Functional Demonstration Test (FDT).
c. Site Acceptance Test (SAT).

D. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provide all special testing materials and equipment required for a suitable means of simulation.

E. PCSS shall coordinate all required testing with Contractor, affected Subcontractors, Engineer, and Owner.

F. No equipment shall be shipped to jobsite until Engineer or Owner has received all Factory Testing results and approved the system as ready for shipment.

G. Engineer reserves the right to test or re-test any functions.

H. Correction of Deficiencies:
   1. Deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to Owner.
   2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until specified requirements are met. This work shall be performed at no additional cost to Owner.

3.2 FACTORY TESTING - UNWITNESSED FACTORY TEST (UFT)

A. Purpose of UFT is for PCSS to check system prior to Engineer and/or Owner attending factory testing. This type of testing shall be part of any quality firm's internal QA/QC procedures.

B. Temporary network connections will be required to confirm the network configuration. Temporary wiring of primary elements, final control elements, and field-mounted transmitters is not required.

C. Hardware to be tested shall include all control system devices shown on System Architecture drawings and provided by PCSS.

D. Tests to be performed shall include, but not be limited to, the following. Each of these tests shall be specifically addressed in Test Procedure submittal.
   1. All panels and enclosures being provided shall undergo a thorough inspection to verify integrity of cabinet enclosures, frame structures, paint work and finish, etc. Review panel drawings to ensure they accurately reflect panel layout and wiring.
   2. Perform a system audit to verify all components have been staged for test and have been documented properly with correct model numbers, serial numbers, etc. Following documentation of audit shall be provided at factory test and submitted as part of O&M Manual Documentation:
      a. For each workstation and server, list of all software installed (including the operating system), with software revision number, software improvement modules or patches installed, license number and owner registration information, warranty period, vendor and local distributor names and contacts.
      b. For each microprocessor-based component connected to control communication backbone in system (PLCs, managed switches, protocol converters, communication cards on final field devices, radios, etc.), list firmware revision, vendor and local distributor information, and system, warranty information, configuration parameters (e.g., communication settings, fail position settings, etc.)
   3. Panel wire pull tests shall be performed to ensure all wiring has been connected with appropriate torque to prevent wires from coming loose.
   4. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Testing of UPS to determine if they have been sized correctly to maintain specified run time shall be performed during field testing.
   5. A 100 percent I/O point checkout shall be performed to verify proper operation of input/output points from panel terminations to HMI and OIT nodes. At a minimum, I/O checkout shall consist of four steps.

a. Discrete input signals shall be jumpered at field terminal blocks in control panels to verify proper status in HMI and OIT nodes.
b. Analog input signals shall be connected to a signal generator at field terminal blocks in control panels to verify proper status in HMI and OIT nodes and signals shall be verified at zero percent, 50 percent, and 100 percent of full scale.
c. Discrete output signals shall be tested by switching equipment to manual control at HMI and OIT nodes and turning the output on or other means to turn the output on. Then verify the output is on by connecting a digital multimeter to measure continuity at terminations, thus verifying command from PLC has properly executed contact closure.
d. Analog output signals shall be tested by switching the equipment to manual control at HMI and OIT nodes and turning output on or other means to turn the output on. Then verify output by utilizing a digital multimeter to measure current or voltage generated at termination points.

6. All control strategies shall be verified using simulation or other means to verify logic performs as expected. Verify faults and logical failure conditions for control strategies such instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing (over and under scale) for analog inputs, and all other strategies specified in control strategy document.
7. For each hardware enclosure, inspection shall include, but not be limited to, cabinet enclosures, frame structure, paint work and finish, dimensions, and hardware operability (i.e., fans, door hinges, keylocks, etc.).
8. For each subpanel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.
9. All other control panel circuitry.
10. Following systems tests shall be performed:
    a. Demonstrate ability to share data between operator workstations and servers.
    b. Demonstrate ability of each workstation to print reports on all designated report printers.
    c. Demonstrate ability for each workstation to read and write designated files from servers and other workstations on the network.
    d. Demonstrate operability of all back-up and mass storage equipment.
    e. Demonstrate total power failure and recovery. UPS shall be removed for this test.
    f. Demonstrate failover capabilities of the redundant HMI servers.

E. Upon successful completion of UFT, PCSS shall submit a record copy of test results as specified in PART 1. As part of this test results submittal, notify Engineer and Owner in writing that system is ready for WFT. No other notice of Factory test will be accepted. Engineer and/or Owner shall schedule a test date within 30 days of receipt of this submittal.

3.3 FACTORY TESTING - WITNESSED FACTORY TEST (WFT)

A. Purpose of WFT is to allow Engineer or Owner representatives to witness functionality, performance, and stability of entire hardware and software system as a complete integrated system. WFT shall be run by PCSS and conducted at PCSS's facility.

B. Required Documents for Test:

1. Clean set of approved panel drawings and wiring diagrams.
2. Set of Contract Documents - all drawings and specifications.
3. All design-change related documentation.
4. Master copy of the PCSS developed factory testing signoff forms.
5. Testing procedures.

C. System shall operate continuously throughout WFT without failure, except where initiated per established test procedures. Unanticipated failures may, at Owner or Engineer's option, result in overall WFT being deemed unsuccessful. All deficiencies identified during these tests shall be corrected and re-tested prior to completing WFT or shipment of panels to jobsite as determined by Owner/Engineer.

D. Tests to be performed during the WFT shall include, but not be limited to, the following:
1. A repeat of all tests specified in the UFT.

E. Daily schedule during these tests shall be as follows:
1. Morning meeting to review the day's test schedule.
2. Scheduled tests and sign-offs.
3. End of day meeting to review day's test results and to review or revise next day's test schedule.
4. Unstructured testing period by witnesses.

F. Upon successful completion of WFT, PCSS shall submit a record copy of test results as specified in PART 1.

3.4 FIELD TESTING - OPERATIONAL READINESS TEST (ORT)

A. Purpose of ORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if equipment is ready for operation.

B. This test shall take place prior to FDT and startup. Prior to starting this test, relevant process equipment shall be installed and mechanically tested, instruments installed, control panels installed, and field wiring complete.

C. Required Documents for Test:
1. Master copy of the PCSS developed field testing signoff forms.
2. Testing procedures.
3. Calibration forms.

D. These inspections, calibrations, and tests do not require witnessing. However, Engineer may review and spot-check testing process periodically. All deficiencies found shall be corrected by PCSS prior to commencement of Functional Demonstration Test.

E. PCSS shall maintain Sign-off forms and Calibration forms at job site and make them available to Engineer/Owner at any time.

F. Following tests shall be performed as part of ORT:
1. Instrument calibration, configuration, and set-up.

2. Input/Output (I/O) Testing to HMI and OITs.
3. Testing of control strategies.

G. Instrument calibration, configuration, and set-up:
   1. Calibrate, configure, and set-up all components and instruments to perform specified functions.
   2. Calibration form:
      a. For any component or instrument requiring dip switch settings, calibration, or custom configuration, maintain a calibration form in field documenting this information. These forms shall provide a summary of the actual settings used in the field to allow an Instrument technician to replace the device entirely and configure it to function as it did before.
      b. This information shall be added to Instrument data sheet, shall be added to a copy of manufacturer's standard "Configuration Sheet", or a separate form shall be created.
         1) If a separate form, the form shall list Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.
      c. Some examples of required information are:
         1) For Discrete Devices: Actual trip points and reset points.
         2) For Instruments: Any configuration or calibration settings entered into instrument
         3) For Controllers: Mode settings (PID).
         4) For I/O Modules: Dip switch settings, module configuration (if not documented in native programming documentation).
      d. Maintain a copy of these forms in field during testing and make them available for inspection at any time.
      e. For any device that allows a software back-up of configuration files to a laptop, make configuration files available to Engineer/Owner for inspection. Submit as part of Final System Documentation.

H. I/O Testing:
   1. Purpose of I/O testing is to check that process equipment, instrument installation, calibration, configuration, field wiring, and control panels are set-up correctly to monitor and control the processes. This test is commonly referred to as a "loop test" or an I/O checkout.
   2. PCSS in conjunction with Contractor shall test signals under process conditions. Preferred test method will always be to execute test wherever possible to end elements. For example, preferred test will prove valve open/close limit switches by operating valve, not by installing a jumper on limit switch contacts. However, if equipment or process is not available to test a signal over its entire calibrated range, PCSS may test using a simulation method and make a note on sign-off form.
   3. The following I/O tests shall be performed:
      a. Discrete Input: At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within loop such as HMI screens, OIT screens, pilot lights, horns, beacons, etc.
      b. Analog Input: Test analog signal over entire engineering range at various intervals including 0, 50%, and 100% as well as on increasing and decreasing range. Observe results on all indicators within loop such as HMI screens, OIT screens, recorders, digital indicators, etc.

c. Discrete output signals shall be tested by switching equipment to manual control at the HMI and OIT nodes and turning output on or using other means to turn output on. Then verify equipment responds accordingly.

d. Analog output signals shall be tested by switching equipment to manual control at HMI and OIT nodes and turning output on or other means to turn output on. Then verify equipment responds accordingly.

I. Testing of Automatic Control Strategies:

1. All automatic control strategies shall be verified using actual process equipment and instruments, or other means, to verify logic performs as expected. Verify faults and logical failure scenarios for control strategies such as instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing for analog inputs, loss of power, and all other strategies specified in control strategy document.

J. Repeat all systems tests specified under factory testing.

K. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Also, test sizing of UPS by switching off line power to UPS and verify if they maintain specified run time.

L. For all panels with enclosures modified by this Contract, internal control panel temperature shall be tested under full running conditions to ensure proper cooling/ventilation is being provided.

M. Upon successful completion of ORT, PCSS shall submit a record copy of test results as specified in PART 1 and request scheduling of FDT.

3.5 FIELD TESTING - FUNCTIONAL DEMONSTRATION TEST (FDT)

A. After facility is started-up and running treatment process in automatic control to extent possible, a Functional Demonstration Test shall be performed. Purpose of FDT is to allow Engineer or Owner representatives to witness actual functionality, performance, and stability of system while connected to process equipment.

B. Required Documents for Test:

1. Set of panel drawings and wiring diagrams from ORT with corrections noted.
2. Set of Contract Documents - all drawings and specifications.
3. All design-change related documentation.
4. Signed-off master copy of the PCSS developed field testing signoff forms.
5. Testing procedures.
6. Copy of completed calibration forms.
7. One copy of all O & M Manuals for PCSS supplied equipment.

C. A witnessed FDT shall be performed on each process area. To extent possible, repeat testing performed during ORT.

D. Daily schedule specified to be followed during factory tests shall also be followed during FDT.

E. After coordinating with Operations, a "Black Start" of the plant shall be performed to confirm plant operation recovers as specified in Contract Documents. Black start means shutting off power to the plant and turning it back on. Separate tests shall be performed by recovering the plant while on generator (if a generator is specified) and while on utility power.

F. Punch list items and resolutions noted during test shall be documented on Punch list/Resolution form. In event of rejection of any part or function test procedure, PCSS shall perform repairs, replacement, and/or retest within 10 days.

G. Upon successful completion of the FDT, PCSS shall submit a record copy of test results as specified in "Part 1 - General".

3.6 FIELD TESTING - SITE ACCEPTANCE TEST (SAT)

A. After completion of FDT, and system is started-up and running treatment process in automatic control to extent possible, system shall undergo a test as defined in Division 01 "Equipment Testing and Start-up" Section.

B. While this test is proceeding, Engineer and Owner shall have full use of system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain responsibility of Owner and decision of plant operators regarding plant operations shall be final.

C. During this test, PCSS personnel shall be present as required to address any potential issues that would impact system operation. PCSS is expected to provide personnel for this test who have an intimate knowledge of hardware and software of system. When PCSS personnel are not on-site, PCSS shall provide cell phone/pager numbers that Owner personnel can use to ensure that support staff is available by phone and/or on-site within four hours of a request by operations staff.

D. Any malfunction during test shall be analyzed and corrections made by PCSS. In event of rejection of any part or function, PCSS shall perform repairs or replacement within 5 days.

E. Throughout duration of SAT, no software or hardware modifications shall be made to system without prior approval from Owner or Engineer.

END OF SECTION 406121.02

APPENDIX **406121-**A: EXAMPLE INPUT/OUTPUT (I/O) STATUS SIGN OFF FORM

An example template for I/O Status signoff form to be used for documenting testing results to Owner is attached. PCSS is required, prior to testing, to create a project specific I/O Status signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

APPENDIX **406121**-B: EXAMPLE AUTOMATIC CONTROL STRATEGIES SIGN OFF FORM

An example template for Automatic Control Strategies signoff form to be used for documenting testing results to Owner is attached. PCSS is required, prior to testing, to create a project specific Automatic Control Strategies signoff form based on attached template or approved equal. PCSS may obtain an electronic copy of template from Engineer or develop it on their own.

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[Project Name] Appendix A - Input/Output (I/O) Status Sign-Off Form

All Sections below are required to be filled out by PCSS as part of Field Testing.
Instrument Alarm Setpoint - Setpoint for any alarms set by PCSS
Wiring Complete - Signal wired from field device to PLC
I/O Tested - Signal tested from field device to SCADA HMI

PLC	Signal Tag	Description	Range or Active State when closed	P&ID	Signal	Rack	Slot	Channel	Instrument Alarm Setpoint	Calibrate, config., and Wiring complete	Date	PCSS I/O testing	Date	I/O Testing to the HMI	Date	Notes
PLC-SC	LIT-4000-1	Secondary Clarifier No. 1 Sludge Level	0-10 ft	8	AI	2	1	0								
PLC-SC	LIT-4010-3	Secondary Clarifier No. 3 Sludge Level	0-10 ft	8	AI	2	1	1								
PLC-SC	SI-4100-1	RAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1	2								
PLC-SC	SI-4100-4	RAS Pump No. 4 Speed Feedback	0-100%	15	AI	2	1	3								
PLC-SC	FIT-4102-1	RAS Flow Pumps 1-3	0-1900 GPM	14	AI	2	1	4								
PLC-SC	SI-4110-1	WAS Pump No. 1 Speed Feedback	0-100%	14	AI	2	1	5								
PLC-SC	N/A	Spare Slot	N/A	N/A	Spare	2	5	N/A								
PLC-SC	SC-4100-1	RAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7	0								
PLC-SC	SC-4100-2	RAS Pump No. 2 Speed Setpoint	0-100%	14	AO	2	7	1								
PLC-SC	SC-4100-3	RAS Pump No. 3 Speed Setpoint	0-100%	14	AO	2	7	2								
PLC-SC	SC-4110-1	WAS Pump No. 1 Speed Setpoint	0-100%	14	AO	2	7	3								
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7	4								
PLC-SC	Spare	Spare	N/A	N/A	AO	2	7	5								
PLC-SC	TSH-4000-1	Secondary Clarifier No. 1 High Temp	Normal	8	DI	3	1	0								
PLC-SC	XA-4000-1	Secondary Clarifier No. 1 Motor Overload	Normal	8	DI	3	1	1								
PLC-SC	WAH-4000-1	Secondary Clarifier No. 1 High Torque	Normal	8	DI	3	1	2								
PLC-SC	WAHH-4000-1	Secondary Clarifier No. 1 High High Torque	Normal	8	DI	3	1	3								
PLC-SC	YRI-4000-1	Secondary Clarifier No. 1 On/Off	On	8	DI	3	1	4								
PLC-SC	YCI-4000-1	Secondary Clarifier No. 1 In Remote	In Remote	8	DI	3	1	5								
PLC-SC	YFI-4100-1	RAS Pump No. 1 VFD Fault	Normal	14	DI	3	1	6								
PLC-SC	FAL-4100-1	RAS Pump No. 1 Low Flow	Normal	14	DI	3	1	7	50 GPM	RJM	12/18/2011	JAS	12/22/2011	MIC	12/29/2011	Example completed line
PLC-SC	Spare	Spare	Normal	14	DI	3	1	8								
PLC-SC	YRI-4100-1	RAS Pump No. 1 Running	Running	14	DI	3	1	9								
PLC-SC	YCI-4100-1	RAS Pump No. 1 In Remote	In Remote	14	DI	3	1	10								
PLC-SC	YFI-4110-1	WAS Pump No. 1 VFD Fault	Normal	14	DI	3	1	11								
PLC-SC	FAL-4110-1	WAS Pump No. 1 Low Flow	Normal	14	DI	3	1	12								
PLC-SC	Spare	Spare	Normal	14	DI	3	1	13								
PLC-SC	YRI-4110-1	WAS Pump No. 1 Running	Running	14	DI	3	1	14								
PLC-SC	YCI-4110-1	WAS Pump No. 1 In Remote	In Remote	14	DI	3	1	15								
PLC-SC	HSS-4000-2	Secondary Clarifier No. 2 Start Command	Start	8	DO	4	6	0								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	1								
PLC-SC	HSS-4100-2	RAS Pump No. 2 Start Command	Start	14	DO	4	6	2								
PLC-SC	HSS-7000-2	Sludge Holding Tank Blower No. 2 Start Command	Start	17	DO	4	6	3								
PLC-SC	HSS-4100-5	RAS Pump No. 5 Start Command	Start	15	DO	4	6	4								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	5								
PLC-SC	HSS-4105-1	Secondary Scum Pump No. 2 Start/Stop	Start	15	DO	4	6	6								
PLC-SC	HSS-4110-2	WAS Pump No. 2 Start/Stop Commanded	Start	15	DO	4	6	7								
PLC-SC	7160-FQI-1	Sludge Loadout LCP Pumping Indicator	Pumping	17	DO	4	6	8								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	9								
PLC-SC	HSS-7115-2	Sludge Holding Tank Mixer No. 2 Start	Start	17	DO	4	6	10								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	11								
PLC-SC	HSO-7117-2	Sludge Holding Tank Discharge Valve No. 2 Open CMD	Open	17	DO	4	6	12								
PLC-SC	HSC-7117-2	Sludge Holding Tank Discharge Valve No. 2 Close CMD	Close	17	DO	4	6	13								
PLC-SC	HSS-7120-2	TS Transfer Pump No. 2 Start Command	Start	17	DO	4	6	14								
PLC-SC	Spare	Spare	N/A	N/A	DO	4	6	15								

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[Project Name] Appendix B - Automatic Control Strategies Sign-Off Form

All Sections below are required to be filled out by PCSS as part of Testing

Auto. Control Strategies. - Loop operational in Automatic as defined in Control Stategies

Control Strategies Loop #	Control Strategy Description	P&ID	Auto. Control Strategy	Date	Notes
LOOP 281 - 284	LOW FLOW PUMPS	8			
LOOP 290	LOW EQ CHANNEL FLOW NO.4	8			
LOOP 300	MICROFILTRATION AIR SUPPLY LOW PRESSURE	10			
LOOP 351, 352	SITE LIFT STATION PUMP NO.1 AND NO. 2	12			
LOOP 355	SITE LIFT STATION HIGH AND LOW LEVEL CONTROL	12			
LOOP 371, 372	SLUDGE HOLDING TANK NO.1 AND NO. 2 LEVEL	14			
LOOP 381, 382	SLUDGE TRANSFER PUMPS	14			
LOOP 385	SLUDGE TRANSFER PUMPS REMOTE START/STOP COMMAND	14			
LOOP 700	EFFLUENT PUMPING STATION LEVEL	14			
LOOP 701, 702, 703	EFFLUENT PUMP NO.1	14			
LOOP 840	POST AERATION CHANNEL AIR FLOW CONTROL	15			
LOOP 900	SLUDGE TRANSFER PUMPS DISCHARGE FLOW	8			
LOOP 971	CENTRIFUGE SLUDGE FEED PUMP NO.1	8			
LOOP 1001	CENTRIFUGE NO.1 SLUDGE FEED FLOW CONTROL	8			
LOOP 1411, 1412	SODIUM HYPOCHLORITE STORAGE TANKS LEVEL	8			
LOOP 1421, 1422	SODIUM HYPOCHLORITE PUMPS	8			
LOOP 1430	SODIUM HYPOCHLORITE STORAGE TANKS CONTAINMENT AREA HIGH LEVEL DETECTION	14			
LOOP 2051, 2052, 2053	DIESEL ENGINE GENERATOR STATUS	14			
LOOP 2055	TRANSFER SWITCH STATUS	14			
LOOP 2060	GENERATOR KILOWATTS MONITORING	14			
APPENDIX ONE	EQUIPMENT RESTART DURING A POWER LOSS WITH THE GENERATOR RUNNING	14			
APPENDIX TWO	EQUIPMENT RESTART WITH POWER RESTORED AFTER A POWER LOSS	14			
N/A	SELF-HEALING CAPABILITIES OF NETWORK	N/A			
N/A	REDUNDANT SCADA SERVER FAILOVER AND RECOVERY	N/A			

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SECTION 406126 - PROCESS CONTROL SYSTEM TRAINING

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 training requirements of the process control system.

B. Related Requirements:
   1. Section 406863 “Configuration of HMI Software” for AESS training requirements.

C. Furnish training as specified herein.

D. This Section covers the training requirements for all devices and systems furnished and installed as detailed on the Drawings.

E. Refer to Section 406100.

1.3 ACTION SUBMITTALS

A. Preliminary Training Plan Submittal:
   1. Prior to the preparation of the Final Training Plans, submit outlines of each training course including course objectives and target audience, resumes of instructors, prerequisite requirements for each class, and samples of handouts for review.

B. Final Training Plan Submittal:
   1. Upon receipt of the Engineer's comments on the preliminary training plan, submit the specific proposed training plan with the following:
      a. Definitions, objectives, and target audience of each course.
      b. Schedule of training courses including proposed dates, duration and locations of each class.
      c. Complete copy of all proposed handouts and training materials bound and logically arranged with all materials reduced to a maximum size of 11 inch by 17 inch, then folded to 8.5 inch by 11 inch for inclusion into the binder.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The training and instruction shall be directly related to the system being supplied. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.

B. Coordinate all training schedules with and at the convenience of the Owner, including shift training required to correspond to the Owner's working schedule.

C. All onsite instructors must be intimately familiar with the operation and control of the Owner's facilities.

D. Provide detailed training manuals to supplement the training courses including specific details of equipment supplied and operations specific to the project. The manuals shall be provided in hardcopy for each student. Provide electronic copy of each training manual in PDF format for Owner's future use.

E. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.

F. The Owner reserves the right to videotape all custom training sessions. All training tapes become the sole property of the Owner.

G. Cost of Travel for off-site training:
   1. Cost of Travel for off-site training is paid directly by the entity employing the staff doing the traveling.

3.2 TRAINING SUMMARY

A. Provide the following training courses listed in the summary table below:

Description	Minimum Course Duration (hours)	Maximum Number of Trainees per Course	Number of Times Course to be Given	Intended Audience
Onsite Training				
Control System Overview Seminar	Covered in AESS scope of work			
Operator Control System Training	Covered in AESS scope of work			
System Reports and Historian Implementation	Covered in AESS scope of work			
Installed Control System	4	2	1	Maintenance, Administrator
PLC Hardware/Software	2	2	1	Maintenance
Instrument manufacturer training - analyzers	4	2	1	Maintenance
Instruments	4	2	1	Maintenance
Instruments - Operator familiarity	2	8	1	Operations

Fiber Optics	1	2	1	Maintenance

B. Definitions of audience roles:
   1. Administrator - personnel responsible for maintaining the HMI / SCADA system.
   2. Maintenance - personnel responsible for maintaining the field controller hardware and instrumentation system.
   3. Operations - personnel responsible for daily plant operations.
   4. Management - non-daily operations personnel

3.3 ONSITE TRAINING

A. Training personnel are required to be intimately familiar with the control system equipment, its manipulation, and configuration. Training personnel are required to command knowledge of system debugging, program modification, troubleshooting, maintenance procedure, system operation, and programming, and capable of transferring this knowledge in an orderly fashion to technically oriented personnel.

B. Installed Control System Training:
   1. Provide training for the Owner's personnel in the functionality, maintenance, and troubleshooting, of the installed Control System. The training shall be held before the Functional Demonstrator Test (FDT), but not more than two months before.
   2. Provide training and instruction specific to the system that is being supplied.
   3. Provide training consisting of classroom instructions and hands-on instruction utilizing the Owner's system.
   4. Provide detailed training on the actual configuration and implementation for this Contract covering all aspects of the system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the system. Provide training covering the following subjects:
      a. System overview.
      b. System hardware components and specific equipment arrangements.
      c. Periodic maintenance.
      d. Troubleshooting and diagnosis.
      e. Network configuration, communications, and operation.
      f. TCP/IP addressing procedures for all Ethernet devices.

C. Programmable Logic Controller (PLC) Hardware and Software:
   1. Provide training for the Owner's personnel in the operation, maintenance, troubleshooting, etc. with the PLC hardware and software system. The training shall be held before the FDT, but not more than two months before.
   2. Provide training and instruction specific to the system that is being supplied.
   3. Provide training consisting of classroom instructions and hands-on instruction utilizing the Owner's system. Provide detailed training on the actual configuration and implementation for this Contract covering all aspects of the PLC system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the PLC system. Provide training covering the following subjects:
      a. PLC system overview.
      b. PLC system architecture.
      c. PLC system hardware components and specific equipment arrangements.
      d. PLC system startup, shut down, load, backup, and PLC failure recovery.
      e. Periodic maintenance.

f. Troubleshooting and diagnosis down to the I/O card level.
g. PLC configuration, communications, and operation.

D. Instrument Manufacturer Training:
1. Provide manufacturer instrument training for those instruments where specifically indicated in the Instruments section. This is on-site training provided by an authorized representative of the manufacturer. The manufacturer's representative is required to be fully knowledgeable in the operation and maintenance of the equipment.

E. Instrument Training:
1. Provide instruction on the maintenance of the field and panel instrumentation for the Owner's instrumentation technicians. Conduct this training before the FDT, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. Training program is required to include the following elements:
a. Training in standard hardware maintenance for the instruments provided.
b. Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this Contract.
c. Testing, adjustment, and calibration procedures.
d. Troubleshooting and diagnosis.
e. Maintenance and frequency.

F. Instruments - Operator familiarity:
1. Provide operator level instruction on the use of the field and panel instrumentation for the Owner's operations staff. Conduct training before the 30-day site acceptance test, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. Include hands on demonstration of the information each transmitter indicates, and the method used to retrieve any operator information from the transmitter, including use of pushbuttons and interpretation of international graphic symbols used on the instruments.

G. Fiber Optic Training:
1. Provide instruction on the maintenance of the fiber optic system for the Owner's instrumentation technicians. Conduct training before the FDT, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. Provide training covering the following topics:
a. Fiber cable layout and basic of cable construction.
b. Termination procedures.
c. "Jumper" installation.
d. Testing procedures.
e. Troubleshooting and diagnosis.

END OF SECTION 406126

SECTION 406196 - PROCESS CONTROL DESCRIPTIONS

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 process control descriptions.

B. This Section is provided to clarify the control strategies to be used to program the system.

C. All SCADA System PLC controller programming and SCADA Operator Interface Terminal (OIT) or Operator Workstation Station (OWS) graphics and programming shall be performed as defined in Section 406263 - Operator Interface Terminals.

1.3 DEFINITIONS

A. CI: Corrosion Inhibitor

B. Caustic: Caustic Soda

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The control descriptions are broken into areas. The following is a list of areas and the loop numbers associated with each area.

1.	Chemical Feed Locations	0000-0999
	Sodium Hypochlorite System.	1000-1999
	Caustic Soda System	2000-2999
	Corrosion Inhibitor System	3000-3999

B. The control descriptions are sorted by loop number for each area. The loop index has three columns associated with it; Loop Number, Loop Description, and Page. Each loop is associated with a specific SCADA I/O cabinet location to which it shall communicate.

C. The control descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. An example of multiple layered loop is as follows. The lowest layer of control, local control, is at that piece of equipment or that piece of equipment's panel or drive. The second layer of control is at an intermediate control panel between the equipment and the SCADA I/O or vendor's PLC I/O. The third layer would be at the vendor's PLC or microprocessor touchscreen station. The highest layer of control is by the SCADA PLC System with its associated operator workstations (OWS) in the main control room, remote office locations, and satellite locations operator interface terminals (OITs). The SCADA PLC/ OWS refers to both the SCADA PLC, which does the actual monitoring and control logic for the process equipment and the SCADA operator workstation (OWS), which are computers that have graphical software that interface to the PLC software for monitoring and implementing all operator-required tasks to control that process equipment. Any functions done in the operator workstations also take place at all the SCADA OITs.

3.2 CONTROL FUNCTION DEFINITIONS AND GENERAL CRITERIA

A. The hardware and/or software functions noted by this paragraph reference are to be implemented by the SCADA PLC/OWS control system specified herein.

B. The following list of ISA abbreviations is typical of those utilized. The description, following the abbreviation, summarizes the basic function to be implemented in the SCADA PLC/OWS software.

1. HS: Represent selector switches or pushbuttons, which shall be implemented by keyboard entry. Function shall be similar to their hardware counterparts. Examples are as follows:
   a. HSH-Open Command.
   b. HSL-Close Command.
   c. HSS-Start/Stop Command.
2. YI: Represents equipment status (i.e., availability, running, in remote, etc.) implemented by a change of color on the OWS symbol for this equipment. For motor driven equipment such as pumps, blowers, compressors, etc., availability contact represents remote operation and no alarm conditions. Examples are as follows:
   a. YCI-Selector switch in computer, auto or remote position.
   b. YRI-Motor running status.
   c. YFI-Motor failure or overload status.
   d. YMI-Selector switch in maintenance position.
3. PAL, AAH, UA, etc.: Represent high or low alarms implemented on the OWS.
4. FIC, PIC, AIC, etc.: Represent PID process controllers implemented in a computer logic algorithm incorporating proportional, integral, and/or derivative modes. Local/remote and manual/auto capabilities shall be provided.
5. FIK, PIK, AIK, etc.: Represent control stations implemented in logic (via keyboard entry and CRT display) to allow downloading of a set point to a FIC, PIC, AIC, etc., and display of the process variable or controller output.
6. FI, PI, AI, etc.: Represent digital output display on the CRT of a process variable in engineering units and/or a dynamic representation of the variable by symbol or graphical means.
7. FIR, PIR, AIR: Represent values stored on the hard disk to provide the data for historical trend graphics of process variables against time (or other selected variables).
8. ZSH, ZSL etc.: Represent high or low, open or close limit positions implemented on the OWS

C. All interlocks that are represented, before the local operational descriptions, or are stated as hardwired interlocks, shall interlock all the controls locally and at the SCADA PLC/OWS or at the vendor PLCs. The SCADA PLC shall be programmed to shut down that equipment if that hardwired interlock is also wired to the SCADA PLC.

D. All interlocks that are represented in a particular layer of the operational descriptions, shall interlock all the controls in that layer and the layer after it. However, the interlock shall not interlock the commands in the layer before it.

E. The SCADA system shall stop a motor or drive in its program if it does not receive the auto or remote status or one of its software interlocks trip. If the drive or motor is in hand or remote it will continue to run but the SCADA start/stop output will be open.

F. All motors that are requested to start by an operator or an automatic program shall alarm if the run confirm status for that motor does not activate within two seconds. If a motor stops by an interlock or stops without any operator or SCADA intervention, then that motor shall go into alarm. All motors that are stopped by a program or the operator shall not go into an alarm.

G. All valves that are requested to open by an operator or an automatic program shall alarm if the open feedback status for that valve does not activate within ten seconds. All valves that are requested to close by an operator or an automatic program shall alarm if the close feedback status for that valve does not activate within ten seconds.

H. Motors that have an H/O/A shall indicate to the operator that the pump is being run in the "Hand" position. A motor is being run in "Hand" when the "Auto" position is not true and the run confirm status is true. If not in "Auto" the SCADA PLC shall open up its output contact to stop (shutdown) the pump from SCADA.

I. All motors or shall be programmed so if a motor stops for any reason, it shall not be re-started automatically once the problem with the motor has been resolved. The start command on the OWS shall not be a maintained contact but a momentary command to the PLC. The run confirms of all motors shall seal in the control output to the motor once the momentary start command drops out. The run confirms shall be on a five second timer delay in that if the run confirm is not present after five seconds, the contact output to the motor from the PLC shall drop out. Thus, the only way a motor can be restarted after five seconds by the SCADA system is if the operator reinitiates the start command for that motor on the OWS or when that motor control at the OWS is placed in complete automatic mode and the SCADA computer through logic/interlocks requests the motor to run.

J. Terminology associated with interlocks is as follows:
   1. When a contact or status is true, the SCADA computer will receive power to its input channel. The SCADA computer registers this as a binary bit of one.
   2. When a contact or status is false, the SCADA computer will receive no power (open circuit) to its input channel. The SCADA computer registers this as a binary bit of zero.

K. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following SCADA programming shall take place:
   1. Alarm the signal at any local OITs and in the HMI system.
   2. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual.

3. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.

L. Disable all alarms on analog inputs unless specifically called for in the drawings or specifications.

M. All interlocks that shutdown (Stop a piece of equipment and prevent it from being restarted or moved) shall be shown on the faceplate pop-up graphic for that piece of equipment.

N. The run confirms or on status of all motors and lamps shall be accumulated to calculate a run time status of the equipment on the HMI graphic. Each run time accumulation shall come with a reset button on the HMI screen.

O. All flow indications shall be totalized. Do not totalize if the analog signal is outside the 4-20 mA range. Each flow totalization shall come with a reset button on the HMI screen. Do not totalize if the value of the flow input is less than 2% of the full range of the input.

3.3 INDIVIDUAL CONTROL DESCRIPTIONS AND CONTROL SEQUENCES

LOOP INDEX

LOOP 0100 OUTDOOR BEACON ALARM LIGHT

General: An Outdoor beacon light is energized and alarmed.

Control:

Local:

None

SCADA PLC/OIT/OWS:

The Outdoor beacon shall be energized if any of the alarms below are active:

Emergency Eyewash/Shower at Sodium Hypochlorite Containment Area (ESEW-1020)
Emergency Eyewash/Shower at Caustic Soda Containment Area (ESEW-2020)
Emergency Eyewash/Shower at Fill Stations Area (ESEW-3005)
Emergency Eyewash/Shower at Corrosion Inhibitor Containment Area (ESEW-3010)
Sodium Hypochlorite Bulk Tank No. 1 High-High level (LAHH-1110)
Sodium Hypochlorite Bulk Tank No. 2 High-High level (LAHH-1120)
Sodium Hypochlorite Day tank High-High level (LAHH-1500)
Caustic Soda Bulk Tank High-High level (LAHH-2100)
Caustic Soda Day tank High-High level (LAHH-2500)
Corrosion Inhibitor Bulk Tank High-High level (LAHH-3100)
Corrosion Inhibitor Day tank High-High level (LAHH-3500)
Fire Alarm (XA-1270A)
Fire Alarm Control Panel Trouble Alarm (XA-1270B)

Alarms / Monitoring:

Local:

Beacon lit up on Alarm condition.

SCADA PLC/OIT/OWS:

Beacon Alarm (XA)

LOOP 0101 APPLICATION POINT RESIDUAL CHLORINE ANALYZER

General: Residual chlorine in the treated water is monitored.

Control:

Local:

None

SCADA PLC/OIT/OWS:

The analyzer reading will be used to provide a trim for the sodium hypochlorite flow pacing equation (Refer to Loops 1610 and 1620)

High residual chlorine alarm shall be calculated by comparing the current value to operator adjustable high setpoints (Default = 2 mg/L, adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

High-High residual chlorine alarm shall be calculated by comparing the current value to operator adjustable high-high setpoints (Default = 2.5 mg/L, adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low residual chlorine alarm shall be calculated by comparing the current value to operator adjustable low setpoints (Default = 1 mg/L, adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Low-low residual chlorine alarm shall be calculated by comparing the current value to operator adjustable low-low setpoints (Default = 0.5 mg/L, adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Alarms / Monitoring:

Local:

None

SCADA PLC/OIT/OWS:

High Chlorine Concentration Alarm (AAH)
High-High Chlorine Concentration Alarm (AAHH)
Low Chlorine Concentration Alarm (AAL)
Low-Low Chlorine Concentration Alarm (AALL)
Residual Chlorine Concentration (AI)

LOOP 0102 APPLICATION POINT pH ANALYZER

General: pH of treated water is monitored.

Control:

Local:

None

SCADA PLC/OIT/OWS:

The analyzer reading will be used to provide a trim for the caustic soda flow pacing equation (Refer to Loops 2610 and 2620)

High pH shall be calculated by comparing the current value to operator adjustable high setpoints (Default = 7.5, adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

High-High pH alarm shall be calculated by comparing the current value to operator adjustable high-high setpoints (Default = 7.6, adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low pH alarm shall be calculated by comparing the current value to operator adjustable Low setpoints (Default = 7.4, adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Low-low pH alarm shall be calculated by comparing the current value to operator adjustable low-low setpoints (Default = 7.3, adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Alarms / Monitoring:

Local:

None

SCADA PLC/OIT/OWS:

High pH Alarm (AAH)
Low pH Alarm (AAL)
High-High pH Alarm (AAHH)
Low-Low pH Alarm (AALL)
pH (AI)

LOOP 0103 APPLICATION POINT PHOSPHATE ANALYZER

General: Orthophosphate concentration of treated water is monitored.

Control:

Local:

None

SCADA PLC/OIT/OWS:

The analyzer reading will be used to provide a trim for the Corrosion Inhibitor flow pacing equation (Refer to Loops 3610 and 3620)

High phosphate alarm shall be calculated by comparing the current value to operator adjustable high setpoint (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

High-High phosphate alarm shall be calculated by comparing the current value to operator adjustable high-high setpoint (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low phosphate alarm shall be calculated by comparing the current value to operator adjustable low setpoint (adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Low-Low phosphate alarm shall be calculated by comparing the current value to operator adjustable low-low setpoint (adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

Alarms / Monitoring:

Local:

None

SCADA PLC/OIT/OWS:

High Orthophosphate Alarm (AAH)
High-High Orthophosphate Alarm (AAHH)
Low Orthophosphate Alarm (AAL)
Low-Low Orthophosphate Alarm (AALL)
Orthophosphate Indication (AI)

LOOP 0105 UPS AND MAINTENANCE BYPASS SWITCH MONITORING (TCH-UPS)

General: Continuous monitoring of the UPS and Maintenance Bypass Switch (MBS) statuses at Tank control house (TCH) Building.

Control:

Local:

None

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

UPS on maintenance bypass (XA)
UPS on battery (XA)
UPS fault (XA)
UPS Low battery (XA)

LOOP 0302 SERVICE WATER FLOW TO NEW CHEMICAL BUILDING

General: Service water flow to new chemical building is continuously monitored by means of water meter.

Control:

Local:

None

SCADA PLC/OIT/OWS:

Flow should be totalized inside the PLC.

Alarms / Monitoring:

Local:

Flow indication (FIT)

SCADA PLC/OIT/OWS:

Flow indication (FI)
Today Total Flow (FQIR)
Yesterday Total Flow (FQIR)
Running Total Flow (FQIR)

LOOP 1015 SODIUM HYPOCHLORITE STORAGE TANK FILL VALVE

General: A pair of motorized valves can be opened or closed to divert incoming sodium hypochlorite from the truck to the desired bulk storage tank. They can be controlled locally from the LCP-1200 or valve actuator.

Control:

Hardwired Interlocks:

None

Local (Valve Actuator):

Local: When the Local/Remote switch is in the "Local" position, the motorized valve is opened and closed through a local OSC selector switch on the valve actuator. The OSC selector switch can be in the “Open”, “Stop”, or “Closed” position.

Open: When the OSC selector is in the “open” position, the valve shall open.

Stop: When the OSC switch is in the "Stop" position, the valve shall stop.

Close: When the OSC selector is in the “close” position, the valve shall close.

Remote: When the Local/ Remote pushbutton is in the "Remote" position, the open/close features are transferred to the LCP-1200.

LCP-1200:

Open: When the Open/Close switch is in the "Open" position, the valve shall open. The tank high (LAH-1110) and high-high (LAHH-1110) signal shall be wired as hardwired interlocks to LCP-1200 to prevent the fill valve from opening on a high or high-high level alarm condition.

Close: When the Open/Close switch is in the "Close" position, the valve shall close.

SCADA/OIT:

None

Alarms / Monitoring:

Local (Valve Actuator):

Tank 1 Fill Valve Opened Light (ZLO)
Tank 1 Fill Valve Closed Light (ZLC)

FSCP-1100

Tank 1 Fill Valve Opened Light (ZLO)

LCP-1200

Tank 1 Fill Valve Opened Light (ZLO)
Tank 1 Fill Valve Closed Light (ZLC)

SCADA PLC/OIT:

Valve Opened (ZSO)
Valve Closed (ZSC)

LOOP 1020 EMERGENCY SHOWER AND EYEWASH UNIT (AT CONTAINMENT AREA)

General: The emergency shower and eyewash unit flow switch status is monitored by SCADA.

Control:

Local:

When the silence pushbutton (HS) is pressed, the flow switch alarm shall be reset.

SCADA PLC/OIT

None

Alarms / Monitoring:

Local:

Outdoor Beacon (on southwest corner of building) lit up on flow switch activation (Refer to loop 0100)

SCADA PLC/OIT:

Flow Switch Activated (FAH)

LOOP 1025 SODIUM HYPOCHLORITE STORAGE TANK FILL VALVE

General: Loop 1025 shall be programmed to match the form and functionality of Loop 1015.

LOOP 1103 SODIUM HYPOCHLORTE STORAGE TANK NO. 1 OUTLET VALVE

General: For each tank a motorized ball valve will be provided on the outlet of each storage tank. The valve will be used as emergency shut off valve and isolation valve. The valve is normally open when a tank is in service and will be closed when a tank is put out of service or if a tank leak is detected by a rapid drop in the tank level. When the valve closes automatically, an alarm will be generated in SCADA PLC/OWS to notify the Operator.

Control:

Hardwired Interlocks:

None

Local (Valve Actuator):

Local: When the Local/Remote switch is in the "Local" position, the valve is opened and closed through a local OSC selector switch on the actuator. The OSC selector switch can be in the “Open”, “Stop”, or “Closed” position.

Open: When the OSC selector is in the “open” position, the valve shall open.

Stop: When the OSC switch is in the "Stop" position, the valve will stop

Close: When the OSC selector is in the “close” position, the valve shall close.

Remote: When the Local/Remote pushbutton is in the "Remote" position, the open/close features are transferred to the LCP-1200.

LCP-1200:

Open: When the Open/Close/Auto switch is in the "Open" position, the valve shall open.

Close: When the Open/Close/Auto switch is in the "Close" position, valves shall close.

Auto: When the Open/Close/Auto switch is in the "Auto" position, the control is transferred to SCADA/OIT

SCADA/OIT:

Software Interlock:

The transfer pump shall be prevented from starting if the discharge valves on both the storage tanks are closed.

The outlet valve shall be prevented from opening if the storage tank has a low-low level condition.
The outlet valve will be close automatically, if there is a rapid drop in level alarm

Manual: The valve can be manually opened (HSO) or closed (HSC) from the SCADA/OIT.

Open: When the Open software button is selected, the valve shall open.

Close: When the Close software button is selected, the valve shall close.

Auto: The valve is normally open, when the tank is in service.

The valve shall close automatically, when the operator places tank into "out of service".

The valve shall close automatically, when there is a low-low level condition in the tank or a rapid drop in tank level alarm condition. When the valve closes automatically, an alarm will be generated to notify operator

Alarms / Monitoring:

Local:
Tank 1 Discharge Valve (ZLO)
Tank 1 Discharge Valve (ZLC)

LCP-1200:
Tank 1 Discharge Valve (ZLO)
Tank 1 Discharge Valve (ZLC)

SCADA PLC/OIT:
Valve in Auto (YCI)
Valve Opened (ZSO)
Valve Closed (ZSC)

LOOP 1110 SODIUM HYPOCHLORITE BULK STORAGE TANK NO. 1

General: Only one of the two tanks will be in service at one time to allow accounting of chemical usage and to facilitate control of the feed system. The level in the sodium hypochlorite bulk storage tanks is monitored by means of non-contact radar technology. In addition, there is a high-high level switch, and a low-low level switch. The non-contact radar level will have a low and a high-level alarm.

Control:

Hardwired Interlocks:

If the high-high level switch (LSHH-1110) is tripped, the horn located in FSCP-1100 shall sound indicating to the driver to stop filling the tank. Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will also be energized.

Local:

None

FSCP-1100:

None

LCP-1200:

None

SCADA PLC/OIT/OWS:

The operator shall have capability to select the storage tank and place them online or offline mode. Only one of the two tanks will be in service at one time. If both tanks are offline, the PLC shall command to energize “Both Tank Offline” pilot light (XL-1125) on LCP- 1200 and stop pump.

If both tanks are offline, pumps are not allowed to start from LCP- 1200.

High level alarm shall be calculated by comparing the current value to operator adjustable high setpoints (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current value to operator adjustable low setpoint (adjustable at OIT and HMI). If the current value is lower than the setpoint for a time delay, the alarm shall be activated.

A rapid drop in level alarm shall be programmed for the online tank to alert the operator on rapid drop in tank level. The rapid drop in level alarm shall be calculated by comparing against the current rate of drop in level to a predetermined rate setpoint (adjustable at OIT and HMI) over a time period (adjustable at OIT and HMI). This alarm shall energize pilot light (RDL-1105) on LCP- 1200.

Software Interlock:

None

Alarms / Monitoring:

Local:

Tank No. 1 Level (LI) - Remote Indicator

FSCP-1100:

Tank No. 1 High-High Level Light (LAHH)
Tank No. 1 High Level Light (LAH)
Tank No. 1 Level (LI, 4-20mA = 0-11-ft 8-in or 10-ft 2-in, to be determined during startup)

LCP-1200:

Tank No. 1 High-High Level Light (LAHH)
Tank No. 1 High Level Light (LAH)
Tank No. 1 Low Level Light (LAL)
Tank No. 1 Low-Low Level Light (LALL)
Tank No. 1 Level (LI, 4-20mA = 0-11-ft 8-in or 10-ft 2-in, to be determined during startup)
Rapid drop in Level Light (RDL)
Both Tank offline Light (XL)

SCADA PLC/OIT/OWS:

Tank No. 1 Level (LI, 4-20mA = 0-11-ft 8-in or 10-ft 2-in**,** to be determined during startup)
Tank No. 1 Low-Low Level (LALL)
Tank No. 1 Low Level (LAL)
Tank No. 1 High Level (LAH)
Tank No. 1 High-High Level (LAHH)
Rapid drop in Level (RDLA)

LOOP 1120 SODIUM HYPOCHLORITE BULK STORAGE TANK NO. 2

General: Loop 1120 shall be programmed to match the form and functionality of Loop 1110.

LOOP 1125 SODIUM HYPOCHLORITE FILL STATION PANEL INTRUSION

General: Continuous monitoring of the panel intrusion switch in FSCP-1100.

Control:

Local:

None

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

Panel Intrusion Alarm (XA)

LOOP 1203 SODIUM HYPOCHLORTE STORAGE TANK NO. 2 OUTLET VALVE

General: Loop 1203 shall be programmed to match the form and functionality of Loop 1103.

LOOP 1210 SODIUM HYPOCHLORITE TRANSFER PUMP NO. 1

General: Chemical will be transferred from the bulk storage tanks to the day tanks via transfer pumps. Transfer pump operation shall be manually initiated. The pump will stop if a high-high level alarm is triggered at the Day Tank and will not start if there is a low-low level alarm on the online bulk storage tank.

Control:

Hardwired Interlocks:

If the Day Tank high-high level switch (LSHH-1500) is tripped, the pump shall stop and shall not be allowed to start.

If the Bulk Tank low-low level switch (LSLL-1110) is tripped, pump shall stop and shall not be allowed to start.

If both Outlet valves are closed, pump shall stop and shall not be allowed to start.

If both tanks are offline, the pump shall stop and shall not be allowed to start.

Local (At MCC):

Hand: While the Hand/Off/Remote switch is in the "Hand" position, the pump shall run.

Off: While the Hand/Off/Remote switch is in the "Off" position, motor shall stop.

Remote: When the Hand/Off/Remote selector switch is in the "Remote" position, the control is transferred to LCP-1200, and the Remote Light (YCI) shall turn on.

LCP-1200:

Start/Stop: The operator can Start/Stop the pump from the Start/Stop selector switch.

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

LCP-1200:

Pump Running Light (RL)
Pump Fault Light (YL)
Pump in Remote Light (YCI)

SCADA PLC/OWS/OIT

Pump Running Light (YRI)
Pump Fault Light (YFI)

LOOP 1220 SODIUM HYPOCHLORITE TRANSFER PUMP NO. 2

General: Loop 1220 shall be programmed to match the from and functionality of Loop 1210.

LOOP 1225 SODIUM HYPOCHLORITE LCP-1200 INTRUSION

General: Loop 1225 shall be programmed to match the form and functionality of Loop 1125.

LOOP 1270 FIRE ALARM CONTROL PANEL (FACP) MONITORING

General: Continuous monitoring of the existing Fire alarm Panel status and alarms.

Control:

Hardwired Interlocks:

Fire alarm or panel trouble alarm will energize the building outside beacon light (Loop 0100) on southwest corner of the building**.**

Local:

None

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

Fire Alarm (XA)
Trouble (XA)

LOOP 1275 UPS AND MAINTENANCE BYPASS SWITCH MONITORING (UPS-CHEM)

General: Continuous monitoring of the UPS and Maintenance Bypass Switch (MBS) statuses at new Chemical Building.

Control:

Local:

None

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

UPS on maintenance bypass (XA)
UPS on battery (XA)
UPS fault (XA)
UPS Low battery (XA)

LOOP 1300 SODIUM HYPOCHLORITE SUMP PUMP

General: The containment area sump pump can be manually started and will run until the low-level switch (LSL-1310) is tripped.

Control:

Hardwired Interlocks:

If the containment sump level switch (LSL-1310) is tripped, the sump pump shall stop and shall not be allowed to start.

LCP-1300:

Start/Stop: The operator can Start/Stop the sump pump from the Start/Stop selector switch.

SCADA PLC/OIT/OWS:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OIT/OWS:

Fault (YFI)
Pump Running (YRI)

LOOP 1305 HVAC PANEL MONITORING

General: SCADA will monitor the HVAC panel.

Control:

Local:

Hardwired Interlocks:

None

SCADA PLC/OIT/OWS:

Software Interlock:

None

Alarms / Monitoring:

SCADA PLC/OIT:

General HVAC Alarm (YFI)

LOOP 1310 SODIUM HYPOCHLORITE CONTAINMENT SUMP LEVEL SWITCH

General: The high-level switch in the sodium hypochlorite containment sump will alarm in SCADA and inform the staff that the sump pump needs to run. The low-level switch will be wired as hardwired interlock to sump pump motor starter circuit to prevent the sump pump from running dry.

Control:

Local:

Hardwired Interlocks:

None

SCADA PLC/OIT/OWS:

Software Interlock:

None

Alarms / Monitoring:

SCADA PLC/OIT:

High Level (LAH)

LOOP 1325 PANEL INTRUSION (PLC-CHEM)

General: Loop 1325 shall be programmed to match the form and functionality of Loop 1125.

LOOP 1500 SODIUM HYPOCHLORITE DAY TANK WEIGHT MONITORING

General: The level in the sodium hypochlorite day tank is monitored by means of load cell. The high-high level is also monitored by a high-high level switch. The level of chemical remaining in the tank are calculated in the PLC from the weight measurement and tank size and shall be displayed at the local control panel.

Control:

Local:

Hardwired Interlocks:

If the Day Tank high-high level switch (LSHH-1500) is tripped, the transfer pump (Loop 1210 and 1220) shall stop and Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will be energized.

LCP-1200:

None

SCADA PLC/OIT/OWS:

High level alarm shall be calculated by comparing the current level to operator adjustable high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

High-High level alarm shall be calculated by comparing the current level to operator adjustable high-high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current level to operator adjustable low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

Low-Low level alarm shall be calculated by comparing the current level to operator adjustable low -low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

The chemical usage in gallons shall be calculated for each day.

SCADA PLC/OWS/OIT:

Software Interlock:

The Low-Low level alarm is interlocked with metering pumps 1610 and 1620. If there is a low-low level alarm on the day tank, then the metering pump shall stop and not be allowed to start until operator acknowledges level in day tank is at a satisfactory level to restart the pump

Alarms / Monitoring:

Local:

None

LCP-1200:

Day Tank Level (LI, 4-20mA = 0-3-ft 11-in or 4-ft 4-in, to be determined during Startup)
Day Tank High-High Level Light (LAHH)
Day Tank Low-Low Level Light (LALL)

SCADA PLC/OWS/OIT:

High-High Level (LAHH)

High Level (LAH)
Low-Low Level (LALL)
Low Level (LAL)
Weight Indication (WI, 4-20mA = 0-1150 lb to 1200 lb, to be determined during Startup)
Volume Indication (VLI, 0-1150 lb to 1200 lb = 0-115 or 120 Gallons, to be determined during Startup)
Level Indication (LI, 0-1150 lb to 1200 lb = 0-3-ft 11-in or 4-ft 4-in, to be determined during Startup)
Volume Used Daily (0-115 or 120 Gallons, to be determined during Startup)

LOOP 1610, 1620 SODIUM HYPOCHLORITE METERING PUMPS

General: Sodium hypochlorite in the day tank shall be fed to the application point for final disinfection. Automatic control shall be provided to control the pump speed based on flow pacing and adjustable dosage setpoints which can be "trimmed" using the residual chlorine feedback from AE/AIT 0101.

Control:

Hardwired Interlocks:

If the high discharge pressure switch (PSH) is tripped, the respective metering pump shall stop and shall not be allowed to start.

Local (LCP-1610):

Hand:

When the HOA switch is in "Hand" position, the pump shall start running. The operator can adjust its speed from the speed control potentiometer.

Off:

When the HOA switch is in "Off" position, the pump shall stop running.

Auto:

When the HOA switch is in "Auto" position, the pump's start, stop and speed control is transferred to the SCADA PLC/OWS.

SCADA PLC/OWS/OIT:

Software Interlock:

If the day tank has a low-low level alarm active, the pump shall stop and not be allowed to start until operator acknowledges level in day tank is at a satisfactory level to restart the pump.

Manual Control:

The pump can be started or stopped by the Operator via the Start/Stop software button. The operator shall adjust the speed manually by entering a speed setpoint (0-100%) from SCADA.

Auto Control:

When the loop is placed in auto mode, the pump's speed control shall be controlled by the PLC as described

The measured treated water from GLWA and GCDC shall be used for pacing the chemical pumps using the equation below.

$$\text{Flow Pacing (PH }) = \frac{\text{LWA and CDC Flow (MD }) \times 8.34 \times \text{Adjusted Dose } \left(\frac{\text{mg}}{\text{L}}\right)}{\text{FAC}\left(\frac{\text{lb}}{\text{gal}}\right) \times \frac{24\ Hr}{1\ Day}}$$

GLWA - Water supplied from Great Lakes Water Authority.

GCDC - Water supplied from Genesee County Drain Commissioner.

FAC - Free Available Chlorine.

(GLWA and GCDC Flow) in MGD is the total flow from GLWA and GCDC.

FAC is calculated parameter from chemical concentration on bulk delivery.

$$\text{FAC } \left(\frac{\text{lb}}{\text{gal}}\right) = \frac{\text{Chemical Concentration}(\%) \times 1000 \left(\frac{\text{g}}{\text{L}}\right) \times 3.785 \left(\frac{\text{L}}{\text{gal}}\right)}{453 \left(\frac{\text{g}}{\text{lb}}\right)}$$

Chemical Concentration(%) shall be an operator adjustable based on bulk delivery.

$$\text{Adjusted Dose}\left(\frac{\text{mg}}{\text{L}}\right) = \text{ Dose SP}\left(\frac{\text{mg}}{\text{L}}\right) + \text{Dose Trim } \left(\frac{\text{mg}}{\text{L}}\right)$$

Dose SP (mg/L) shall be an operator adjustable dose set point for the target free residual chlorine adjustable up to 1.5 mg/L.

Dose Trim calculation is described at the end of this loop description

$$\text{Pump Output } (\frac{\text{strokes}}{\text{Hr}}) = \frac{\text{Flow Pacing (PH)}}{\text{Stroke Length } (\frac{\text{gal}}{\text{stroke}})}$$

Pump Output is calculated from the equation above.

Stroke Length $(\frac{\text{gal}}{\text{stroke}})$ shall be an operator adjustable set point.

$$\text{Pump Speed (\%)} = \frac{\text{Pump Output } (\frac{strokes}{\text{Hr}})}{\text{Maximum Pump Capacity } (\frac{strokes}{\text{Hr}})} \text{X100\%}$$

Flow pacing is calculated from the equation above.
Maximum Pump Capacity $(\frac{strokes}{\text{Hr}})$ shall be adjustable during startup based on the supplied pump manufacturer.

Dose Trim, when enabled by the operator from the HMI, is calculated to add a ± 25% to the Dose SP to produce the adjusted dose used in the flow pacing equation above. The Dose Trim is calculated as follows:

Calculate Variance between Dose Setpoint and Delayed Analyzer measurement. The delayed analyzer measurement is the reading of the analyzer X seconds before now and it is used to compensate for the time delay between pumping the chemical and measuring the affect at the analyzer. The delay time should be adjusted during startup.

$$Variance\ (\%) = \frac{Dose\ SP - Delayed\ Analyzer\ Measurment\ (AIT-0101)}{\text{Dose Setpoint}} X100\%$$

a. If Variance is less than 25% or greater than -25%:

   Dose Trim $\left(\frac{\text{mg}}{\text{L}}\right)$ = Dose SP – Delayed Analyzer Measurement

b. If Variance is greater than 25%:

   Dose Trim $\left(\frac{\text{mg}}{\text{L}}\right)$ = Dose SP X 0.25

c. If Variance is less than -25%:

   Dose Trim $\left(\frac{\text{mg}}{\text{L}}\right)$ = Dose SP X -0.25

   If the variance exceeds +/- 25%, the PLC shall limit the dose trim to +/- 25% of the Dose SP entered by the operator and alarm to indicate the Dose trim is being limited.

   If the variance exceeds +/- 10% (operator adjustable), an alarm should be triggered at SCADA.

The feed rate calculation shall be used in conjunction with a two-point calibration equation to control the actual pump speed output. The two-point calibration equation calculates the pump speed required for a feed rate. The calibration equations below are for a direct visual comparison to the pump speed line/curve provided by the manufacturer. The operator will input the calibration results and there will be a line-to-line comparison between the calibration results and the manufacturer's curve. The following items explain this concept:

The following adjustable set points shall be provided at the HMI:
Y1: measure pump speed at calibration point 1
X1: measured feed rate at calibration point 1
Y2: measured pump speed at calibration point 2
X2: measured feed rate at calibration point 2.

The following 2-point linear equation shall be used to control the pump speed output:

Pump Speed = (Feed Rate * Slope) + Y1 – (X1 * Slope)

where Slope = [(Y1-Y2)/(X1-X2)]

Pump Sequence:

The sodium hypochlorite pumps shall operate in a duty/standby strategy.

The duty/standby assignments shall be a manual selection via a software pushbutton at the HMI. The operator shall be prompted to assign a "Duty" pump, and a "Standby" pump. The pumps shall not automatically rotate unless there is a pump failure.

If the duty pump fails, the standby pump shall automatically take its place.

A failed pump shall be taken out of the sequence and marked as out of service.

When the pump is running, and the operator selects the standby pump as duty, the SCADA computer shall start the new duty pump and then stop the new standby pump (old duty) once the new duty pump is running.

Alarms / Monitoring:

Local (at pump):

Leak Alarm light (XA)
High Pressure Alarm Light (PAH)
VFD Fault Light (XA)
Speed Feedback (SI, 4-20mA = 0-100%)

SCADA PLC/OWS/OIT:

Run Confirm Status (YRI)
Pump in Auto (YCI)

Speed Feedback (SI)
Speed Control (SC)
VFD Fault (YFI)
Dosage above High Setpoint (XA)
Trim at Maximum (XA)
Leak (XA)
High Pressure (PAH)

LOOP 1651 SODIUM HYPOCHLORITE CARRIER WATER LOW FLOW SWITCH

General: The carrier water flow is monitored and alarmed at SCADA.

Control:

Hardwired Interlocks:

None

Local:

None

SCADA PLC/OIT/OWS:

If any chemical pump is running and low water flow is detected, an alarm shall be triggered at SCADA. This alarm can be disabled in SCADA, if carrier water is not used.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

Low Flow Alarm (FAL)

LOOP 1710 SODIUM HYPOCHLORITE CARRIER WATER VALVE

General: Carrier water to facilitate feeding of Sodium Hypochlorite is controlled by a solenoid valve.

Control:

Local:

None

LCP-1200:

Open: When the OCA switch is in the "Open" position, the valve shall open.

Close: When the OCA switch is in the "Close" position, the valve shall close.

Auto: When the switch is placed in the "Auto" position, control shall be transferred to SCADA PLC/OWS/OIT.

SCADA PLC/OIT/OWS:

Manual: The valve can be opened and closed from the Open/Close pushbutton from SCADA PLC/OWS/OIT.

Auto: The valve shall open when any chemical pump is confirmed running.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

None

LOOP 2020 CONTAINMENT AREA EMERGENCY SHOWER AND EYEWASH UNIT

General: Loop 2020 shall be programmed to match the form and functionality of Loop 1020.

LOOP 2100 CAUSTIC SODA BULK STORAGE TANK

General: The level in the caustic soda bulk storage tanks is monitored by means of non-contact radar technology. In addition, there is a high-high level switch, and a low-low level switch. The non-contact radar level will have a low and a high-level alarm

Control:

Hardwired Interlocks:

If the high-high level switch (LSHH-2100) is tripped, the horn located in FSCP-2100 shall sound indicating to the driver to stop filling the tank. Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will also be energized.

Local:

None

FSCP-2100:

None

LCP-2200:

None

SCADA PLC/OIT/OWS:

High level alarm shall be calculated by comparing the current value to operator adjustable high setpoints (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current value to operator adjustable Low setpoints (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

A rapid drop in level alarm shall be programmed for the tank to alert the operator on rapid drop in tank level. The rapid drop in level alarm shall be calculated by comparing against the current rate of drop in level to a predetermined rate setpoint (adjustable at OIT and HMI) over a time period (adjustable at OIT and HMI). The rapid drop shall be initially set with a rate of 1-inch per minute. This alarm shall energize pilot light (RDL-2105) on LCP- 2200.

Software Interlock:

None

Alarms / Monitoring:

Local:

Tank Level (LI) - Remote Indicator

FSCP panel:

Level Indication (LI)

Tank High-High Level Light (LAHH)
Tank High Level Light (LAH)

LCP-2200:

Level Indication (LI)
Tank High-High Level Light (LAHH)
Tank High Level Light (LAH)
Tank Low Level Light (LAL)
Tank Low-Low Level Light (LALL)
Rapid drop in Level Light (RDL)

SCADA PLC/OIT/OWS:

Tank Level (LI, 4-20mA = 0-13 feet)
Tank High-High Level (LAHH)
Tank High Level (LAH)
Tank Low Level (LAL)
Tank Low-Low Level (LALL)
Rapid drop in Level (RDLA)

LOOP 2210 CAUSTIC SODA TRANSFER PUMP NO. 1

General: Chemical will be transferred from the bulk tank to the day tank via transfer pumps. Transfer pump operation shall be manually initiated. The pump will stop if a high-high level alarm is triggered at the Day Tank and will not start if there is a low-low level alarm on the bulk storage tank.

Control:

Hardwired Interlocks:

If the Day Tank high-high level switch (LSHH-2500) is tripped, the pump shall stop and shall not be allowed to start.

If the Bulk Tank low-low level switch (LSLL-2100) is tripped, pump shall stop and shall not be allowed to start.

Local(At MCC):

Hand: While the Hand/Off/Remote switch is in the "Hand" position, the pump shall run.

Off: While the Hand/Off/Remote switch is in the "Off" position, motor shall stop.

Remote: When the Hand/Off/Remote selector switch is in the "Remote" position, the control is transferred to LCP-2210, and the Pump in Remote Light (YCI) shall turn on.

LCP-2200:

Start/Stop: The operator can Start/Stop the pump from the Start/Stop selector switch.

SCADA PLC/OWS/OIT:

None

Alarms / Monitoring:

Local:

None

LCP-2200:

Pump Running Light (RL)
Pump Fault Light (YL)
Pump in Remote Light (YCI)

SCADA PLC/OWS/OIT

Pump Running Light (YRI)
Pump Fault Light (YFI)

LOOP 2220 CAUSTIC SODA TRANSFER PUMP NO. 2

General: Loop 2220 shall be programmed to match the form and functionality of Loop 2210.

LOOP 2125 CAUSTIC SODA FILL STATION PANEL INTRUSION

General: Loop 2125 shall be programmed to match the form and functionality of Loop 1125.

LOOP 2225 CAUSTIC SODA LCP-2200 INTRUSION

General: Loop 2125 shall be programmed to match the form and functionality of Loop 1125.

LOOP 2300 CAUSTIC SODA CONTAINMENT SUMP PUMP

General: Loop 2300 shall be programmed to match the form and functionality of Loop 1300

LOOP 2310 CAUSTIC SODA CONTAINMENT SUMP LEVEL SWITCH

General: Loop 2310 shall be programmed to match the form and functionality of Loop 1310

LOOP 2500 CAUSTIC SODA DAY TANK WEIGHT MONITORING

General: The weight in the caustic soda day tank is monitored by means of load cell. The level is also monitored by a high-high level switch. The level of chemical remaining in the tank will be calculated from the chemical weight and tank dimensions and shall be displayed at the local control panel.

Control:

Local:

Hardwired Interlocks:

If the Day Tank high-high level switch (LSHH-2500) is tripped, the transfer pump (Loop 2210 and 2220) shall stop and Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will be energized.

LCP-2200:

None

SCADA PLC/OIT/OWS:

High-High level alarm shall be calculated by comparing the current level to operator adjustable high-high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

High level alarm shall be calculated by comparing the current level to operator adjustable high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current level to operator adjustable low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

Low-Low level alarm shall be calculated by comparing the current level to operator adjustable low-low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

The chemical usage in gallons shall be calculated for each day

SCADA PLC/OWS/OIT:

Software Interlock:

The Low-Low level switch is interlocked with Pumps 2610 and 2620. If the low-low level switch is tripped, the pumps shall stop.

Alarms / Monitoring:

Local:

None

LCP-2200:

Day Tank Level (LI, 4-20mA = 0-5 FT)
Day Tank High-High Level Light (LAHH)
Day Tank Low-Low Level Light (LALL)

SCADA PLC/OWS/OIT:

Level Indication (LI, 4-20mA = 5 FT)
High-High Level (LAHH)
High Level (LAH)
Low-Low Level (LALL)
Low Level (LAL)
Weight Indication (WI, 4-20mA = 0-2800 lb)
Level Indication (LI, 0-2800 lb = 0-5FT)
Volume Indication (VLI, 0-2800 lb = 0-210 Gallons)
Volume Used Daily (0-210 Gallons)

LOOP 2610, 2620 CAUSTIC SODA METERING PUMPS

General: Caustic soda in the day tank shall be fed to the application point for pH control. Automatic control shall be provided to control the pump speed based on flow pacing and adjustable dosage setpoints which can be "trimmed" using the pH feedback from AE/AIT 0102.

Control:

Hardwired Interlocks:

If the high-pressure switch alarm (PSH) at pump's discharge is tripped, the respective metering pump shall stop and a high-pressure alarm shall be received at the SCADA PLC/OWS system.

Software Interlock:

Low-Low level alarm at the day tank shall stop the feed pumps and not be allowed to start until operator acknowledges level in day tank is at a satisfactory level to restart the pump.

Local (LCP-2610):

Hand:

When the HOA switch is in "Hand" position, the pump shall start running. The operator can adjust its speed from the speed control potentiometer.

Off:

When the HOA switch is in "Off" position, the pump shall stop running.

Auto:

When the HOA switch is in "Auto" position, the pump start, stop and speed control is transferred to the SCADA PLC/OWS.

SCADA PLC/OWS/OIT:

Manual Control:

The pump can be started or stopped by the Operator via the Start/Stop software button. The operator should adjust the speed manually by entering a speed setpoint (0-100%) from SCADA.

Auto Control:

When the loop is placed in auto mode, the pump's speed control shall be controlled by the PLC as described

The measured treated water from GLWA and GCDC shall be used for pacing the chemical pumps using the equation below.

$$\text{Flow Pacing (PH)} = \frac{\text{LWA and CDC Flow (MD)} \times 8.34 \times \text{Adjusted Dose } \left(\frac{\text{mg}}{\text{L}}\right)}{\text{ACS}\left(\frac{\text{lb}}{\text{gal}}\right) \times \frac{24\ Hr}{1\ Day}}$$

GLWA - Water supplied from Great Lakes Water Authority.

GCDC - Water supplied from Genesee County Drain Commissioner.

ACS - Available Sodium Hydroxide.

(GLWA and GCDC Flow) in MGD is the total flow from GLWA and GCDC.

ACS is calculated parameter from chemical concentration on bulk delivery.

$$\text{ACS}\left(\frac{\text{lb}}{\text{gal}}\right) = \frac{\text{Chemical Concentration(\%)} \times 1000\left(\frac{\text{g}}{\text{L}}\right) \times 3.785\ \left(\frac{\text{L}}{\text{gal}}\right)}{453\left(\frac{\text{g}}{\text{lb}}\right)}$$

Chemical Concentration(%) shall be an operator adjustable based on bulk delivery.

$$\text{Adjusted Dose}\left(\frac{\text{mg}}{\text{L}}\right) = \text{Dose SP}\left(\frac{\text{mg}}{\text{L}}\right) + \text{Dose Trim}$$

Dose Range is for pH changes between 0.1 to 0.3 pH units, which is from 1.85 to 5.00 mg/L of sodium hydroxide.

Dose SP (mg/L) shall be an operator adjustable dose set point for the target pH adjustable up to a maximum of 0.3 pH units change.

Dose Trim calculation is described at the end of this loop description

$$\text{Pump Output}\left(\frac{\text{strokes}}{\text{Hr}}\right) = \frac{\text{Flow Pacing (PH)}}{\text{Stroke Length}\left(\frac{\text{gal}}{\text{stroke}}\right)}$$

Pump Output is calculated from the equation above.

Stroke Length $\left(\frac{\text{gal}}{\text{stroke}}\right)$ shall be an operator adjustable set point.

$$\text{Pump Speed (\%)} = \frac{\text{Pump Output}\left(\frac{strokes}{\text{Hr}}\right)}{\text{Maximum Pump Capacity}\left(\frac{strokes}{\text{Hr}}\right)} \text{X100\%}$$

Flow pacing is calculated from the equation above.

Maximum Pump Capacity $\left(\frac{strokes}{\text{Hr}}\right)$ shall be adjustable during startup based on the supplied pump manufacturer.

Dose Trim, when enabled by the operator from the HMI, is calculated to add a ± 25% to the Dose SP to produce the adjusted dose used in the flow pacing equation above. The Dose Trim is calculated as follows:

Calculate Variance between the Expected pH and Delayed pH Analyzer measurement. Expected pH is an operator input that is only for trim control since the pH analyzer does not measure mg/L of sodium hydroxide. The delayed analyzer measurement is the reading of the analyzer X seconds before now and it is used to compensate for the time delay between pumping the chemical and measuring the affect at the analyzer. The delay time should be adjusted during startup.

$$Variance\ (\%) = \frac{Expected\ pH - Delayed\ pH\ Analyzer\ Measurment\ (AIT-0102)}{\text{Expected pH}} X100\%$$

a. If Variance is less than 25% or greater than -25%:

   Dose Trim = Expected pH – Delayed pH Analyzer Measurement

b. If Variance is greater than 25%:

Dose Trim = Dose SP X 0.25

c. If Variance is less than -25%:

Dose Trim = Dose SP X -0.25

If the variance exceeds +/- 25%, the PLC shall limit the dose trim to +/- 25% of the Dose SP entered by the operator and alarm to indicate the Dose trim is being limited.

If the variance exceeds +/- 10% (operator adjustable), an alarm should be triggered at SCADA.

The feed rate calculation shall be used in conjunction with a two-point calibration equation to control the actual pump speed output. The two-point calibration equation calculates the pump speed required for a feed rate. The calibration equations below are for a direct visual comparison to the pump speed line/curve provided by the manufacturer. The operator will input the calibration results and there will be a line-to-line comparison between the calibration results and the manufacturer's curve. The following items explain this concept:

The following adjustable set points shall be provided at the HMI:
Y1: measure pump speed at calibration point 1
X1: measured feed rate at calibration point 1
Y2: measured pump speed at calibration point 2
X2: measured feed rate at calibration point 2.

The following 2-point linear equation shall be used to control the pump speed output:

Pump Speed = (Feed Rate * Slope) + Y1 – (X1 * Slope)

where Slope = [(Y1-Y2)/(X1-X2)]

Pump Sequence:

The caustic soda pumps shall operate in a duty/standby strategy.

The duty/standby assignments shall be a manual selection via a software pushbutton at the HMI. The operator shall be prompted to assign a "Duty" pump, and a "Standby" pump. The pumps shall not automatically rotate unless there is a pump failure.

If the duty pump fails, the standby pump shall automatically take its place.

A failed pump shall be taken out of the sequence and marked as out of service.

When the pump is running, and the operator selects the standby pump as duty, the SCADA computer shall start the new duty pump and then stop the new standby pump (old duty) once the new duty pump is running.

Alarms / Monitoring:

Local (at pump):

Leak Alarm light (XA)
High Pressure Alarm Light (PAH)
VFD Fault Light (XA)
Speed Feedback (SI, 4-20mA = 0-100%)

SCADA PLC/OWS/OIT:

Run Confirm Status (YRI)
Pump in Auto (YCI)
Speed Feedback (SI)
Speed Control (SC)
VFD Fault (YFI)
Dosage Trim Limited (XA)
Variance at Maximum (XA)
Leak (XA)
High Pressure (PAH)

LOOP 2651 CAUSTIC SODA CARRIER WATER LOW FLOW SWITCH

General: The carrier water flow is monitored and alarmed at SCADA.

Control:

Hardwired Interlocks:

None

Local:

None

SCADA PLC/OIT/OWS:

If any chemical pump is running and low water flow is detected, an alarm shall be triggered at SCADA. This alarm can be disabled in SCADA, if carrier water is not used.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

Low Flow Alarm (FAL)

LOOP 3005 TANK FILL AREA EMERGENCY SHOWER AND EYEWASH UNIT

General: Loop 3005 shall be programmed to match the form and functionality of Loop 1020.

LOOP 3010 CONTAINMENT AREA EMERGENCY SHOWER AND EYEWASH UNIT

General: Loop 3010 shall be programmed to match the form and functionality of Loop 1020.

LOOP 3100 CORROSION INHIBITOR BULK STORAGE TANK

General: The level in the corrosion inhibitor bulk storage tanks is monitored by means of non-contact radar technology. In addition, there is a high-high level switch, and a low-low level switch. The non-contact radar level will have a low and a high-level alarm

Control:

Local:

None

Hardwired Interlocks:

If the high-high level switch (LSHH-3100) is tripped, the horn located in FSCP-3100 shall sound and the LAHH light shall illuminate, indicating to the driver to stop filling the tank. Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will also be energized.

If the low-low level switch (LSLL-3100) is tripped for a time delay, the transfer pump shall stop running.

SCADA PLC/OIT/OWS:

High level alarm shall be calculated by comparing the current value to operator adjustable high setpoints (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current value to operator adjustable Low setpoints (adjustable at OIT and HMI). If the current value is higher than the setpoint for a time delay, the alarm shall be activated.

A rapid drop in level alarm shall be programmed for the tank to alert the operator on rapid drop in tank level. The rapid drop in level alarm shall be calculated by comparing against the current rate of drop in level to a predetermined rate setpoint (adjustable at OIT and HMI) over a time period (adjustable at OIT and HMI). The rapid drop shall be initially set with a rate of 1-inch per minute. This alarm shall energize pilot light (RDL-3105) on LCP- 3200

Software Interlock:

None

Alarms / Monitoring:

Local:

Tank Level (LI) - Remote Indicator

FSCP panel:

Level Indication (LI)
Tank High-High Level Light (LAHH)
Tank High Level Light (LAH)

LCP-3200:

Level Indication (LI)
Tank High-High Level Light (LAHH)
Tank High Level Light (LAH)
Tank Low Level Light (LAL)
Tank Low-Low Level Light (LALL)
Rapid drop in Level Light (RDL)

SCADA PLC/OIT/OWS:

Tank Level (LI, 4-20mA = 0-8-feet 4-inches to 8-feet 6-inches to be determined during startup)
Tank High-High Level (LAHH)
Tank Low-Low Level (LALL)
Tank High Level (LAH)
Tank Low Level (LAL)
Rapid drop in Level (RDLA)

LOOP 3210 CORROSION INHIBITOR TRANSFER PUMP NO. 1

General: Chemical will be transferred from the bulk storage tanks to the day tanks via transfer pumps. Transfer pump operation shall be manually initiated. The pump will stop if a high-high level alarm is triggered at the Day Tank and will not start if there is a low-low level alarm on the bulk storage tank.

Control:

Hardwired Interlocks:

If the Day Tank high-high level alarm (LAHH-3500) is tripped, the pump shall shutdown.

If the Storage Tank low-low level alarm (LALL-3100) is tripped, the pump shall shutdown.

Local:

Hand: While the Hand/Off/Remote switch is in the "Hand" position, the pump shall run.

Off: While the Hand/Off/Remote switch is in the "Off" position, motor shall stop.

Remote: When the Hand/Off/Remote selector switch is in the "Remote" position, the control is transferred to LCP-3200 and the Pump in Remote Light (YCI) shall turn on.

LCP-3200:

Start/Stop: The operator can Start/Stop the pump from the Start/Stop selector switch.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

LCP-3200:

Pump Running Light (RL)
Pump Fault Light (YL)
Pump in Remote Light (YCI)

SCADA PLC/OWS/OIT

Pump Running Light (YRI)
Pump Fault Light (YFI)

LOOP 3220 CORROSION INHIBITOR TRANSFER PUMP NO. 2

General: Loop 3220 shall be programmed to match the from and functionality of Loop 3210.

LOOP 3125 CORROSION INHIBITOR FILL STATION PANEL INTRUSION

General: Loop 3125 shall be programmed to match the form and functionality of Loop 1125.

LOOP 3225 CORROSION INHIBITOR LCP-3200 INTRUSION

General: Loop 3125 shall be programmed to match the form and functionality of Loop 1125.

LOOP 3300 CORROSION INHIBITOR CONTAINMENT SUMP PUMP

General: Loop 3300 shall be programmed to match the form and functionality of Loop 1300.

LOOP 3310 CORROSION INHIBITOR CONTAINMENT SUMP FLOAT SWITCH

General: Loop 3310 shall be programmed to match the form and functionality of Loop 1310.

LOOP 3500 CORROSION INHIBITOR DAY TANK WEIGHT MONITORING

General: The weight in the corrosion inhibitor day tank is monitored by means of load cell. The level is also monitored by a high-high level switch. The level of chemical remaining in the tank are calculated in the PLC from the weight measurement and the tank dimensions and shall be displayed at the local control panel.

Control:

Local:

Hardwired Interlocks:

If the Day Tank high-high level switch (LSHH-3500) is tripped, the transfer pump (Loop 3210 and 3220) shall stop and Outdoor Beacon Light Alarm (Loop 0100) southwest corner of the building will be energized.

LCP-3200:

None

SCADA PLC/OIT/OWS:

High level alarm shall be calculated by comparing the current level to operator adjustable high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

High-High level alarm shall be calculated by comparing the current level to operator adjustable high-high setpoint (adjustable at OIT and HMI). If the current level is higher than the setpoint for a time delay, the alarm shall be activated.

Low level alarm shall be calculated by comparing the current level to operator adjustable low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

Low-Low level alarm shall be calculated by comparing the current level to operator adjustable low-low setpoint (adjustable at OIT and HMI). If the current level is lower than the setpoint for a time delay, the alarm shall be activated.

The chemical usage in gallons shall be calculated for each day

SCADA PLC/OWS/OIT:

Software Interlock:

The Low-Low level alarm is interlocked with Pumps 3610 and 3620. If the low-low level switch is tripped, the pumps shall stop the feed pumps and not be allowed to start until operator acknowledges level in day tank is at a satisfactory level to restart the pump.

Alarms / Monitoring:

Local:

None

LCP-3210:

Day Tank Level (LI, 4-20mA = 0-3.5 FT)
Day Tank High-High Level Light (LAHH)
Day Tank Low-Low Level Light (LALL)

SCADA PLC/OWS/OIT:

Level Indication (LI, 4-20mA = 3.5 FT)
High-High Level (LAHH)
High Level (LAH)
Low-Low Level (LALL)
Low Level (LAL)
Weight Indication (WI, 4-20mA = 0-785lb)
Volume Indication (VLI, 0-785 lb = 0-60Gallons)
Volume Used Daily (0-60 Gallons)

LOOP 3610, 3620 CORROSION INHIBITOR METERING PUMPS

General: Corrosion inhibitor in the day tank shall be fed to the application point for phosphate control. Automatic control shall be provided to control the pump speed based on adjustable dosage setpoints which can be "trimmed" using the phosphate feedback from AE/AIT 0103.

Control:

Hardwired Interlocks:

If the high-pressure switch alarm (PSH) at pump's discharge is tripped, the respective metering pump shall stop, and a high-pressure alarm shall be received at the SCADA PLC/OWS system.

Software Interlock:

Low-Low level alarm at the day tank shall stop the feed pumps and not be allowed to start until operator acknowledges level in day tank is at a satisfactory level to restart the pump.

Local (LCP-3610):

Hand:

When the HOA switch is in "Hand" position, the pump shall start running. The operator can adjust its speed from the speed control potentiometer.

Off:

When the HOA switch is in "Off" position, the pump shall stop running.

Auto:

When the HOA switch is in "Auto" position, the pump start, stop and speed control is transferred to the SCADA PLC/OWS.

SCADA PLC/OWS/OIT:

Manual Control:

The pump can be started or stopped by the Operator via the Start/Stop software button. The operator should adjust the speed manually by entering a speed setpoint (0-100%) from SCADA.

Auto Control:

When the loop is placed in auto mode, the pump's speed control shall be controlled by the PLC as described

The measured treated water from GLWA and GCDC shall be used for pacing the chemical pumps using the equation below.

$$\text{Flow Pacing (PH }) = \frac{\text{LWA and CDC Flow (MD }) \times 8.34\left(\frac{\text{lb}}{\text{gal}}\right) \times \text{Adjusted Dose } \left(\frac{\text{mg}}{\text{L}}\right)}{\text{ACI}\left(\frac{\text{lb}}{\text{gal}}\right) \times \frac{24\ Hr}{1\ Day}}$$

GLWA - Water supplied from Great Lakes Water Authority.

GCDC - Water supplied from Genesee County Drain Commissioner.

ACI - Available Corrosion Inhibitor.

(GLWA and GCDC Flow) in MGD is the total flow from GLWA and GCDC.

ACI is calculated parameter from chemical concentration on bulk delivery.

$$\text{ACI}\left(\frac{\text{lb}}{\text{gal}}\right) = \frac{\text{Chemical Concentration(\%) } \times 1000\left(\frac{\text{g}}{\text{L}}\right) \times 3.785\ \left(\frac{\text{L}}{\text{gal}}\right)}{453\left(\frac{\text{g}}{\text{lb}}\right)}$$

Chemical Concentration(%) shall be an operator adjustable based on bulk delivery.

$$\text{Adjustable Dose}\left(\frac{\text{mg}}{\text{L}}\right) = \text{ Dose SP}\left(\frac{\text{mg}}{\text{L}}\right) + \text{Dose Trim}$$

Dose SP (mg/L) shall be an operator adjustable dose set point for the target Phosphate adjustable up to the maximum setting as determined by the City (mg/L).

Dose Trim calculation is described at the end of this loop description

$$\text{Pump Output } (\frac{\text{strokes}}{\text{Hr}}) = \frac{\text{Flow Pacing (PH }) }{\text{Stroke Length } (\frac{\text{gal}}{\text{stroke}})}$$

Flow pacing is calculated from the equation above.

Stroke Length $(\frac{\text{gal}}{\text{stroke}})$ shall be an operator adjustable set point.

$$\text{Pump Speed (\%)} = \frac{\text{Pump Output } (\frac{strokes}{\text{Hr}})}{\text{Maximum Pump Capacity } (\frac{strokes}{\text{Hr}})} \text{X100\%}$$

Pump Output is calculated from the equation above.
Maximum Pump Capacity ($\frac{strokes}{\text{Hr}}$) shall be adjustable during startup based on the supplied pump manufacturer.

Dose Trim, when enabled by the operator from the HMI, is calculated to add a ± 25% to the Dose SP to produce the adjusted dose used in the flow pacing equation above. The Dose Trim is calculated as follows:

Calculate Variance between Dose Setpoint and Delayed Analyzer measurement. The delayed analyzer measurement is the reading of the analyzer X seconds before now and it is used to compensate for the time delay between pumping the chemical and measuring the affect at the analyzer. The delay time should be adjusted during startup.

$$Variance\ (\%) = \frac{Dose\ SP - Delayed\ Analyzer\ Measurment\ (AIT-0103)}{\text{Dose Setpoint}} X100\%$$

a. If Variance is less than 25% or greater than -25%:

   Dose Trim = Dose SP – Delayed Analyzer Measurement

b. If Variance is greater than 25%:

   Dose Trim = Dose SP X 0.25

c. If Variance is less than -25%:

   Dose Trim = Dose SP X -0.25

   If the variance exceeds +/- 25%, the PLC shall limit the dose trim to +/- 25% of the Dose SP entered by the operator and alarm to indicate the Dose trim is being limited.

   If the variance exceeds +/- 10% (operator adjustable), an alarm should be triggered at SCADA.

   The feed rate calculation shall be used in conjunction with a two-point calibration equation to control the actual pump speed output. The two-point calibration equation calculates the pump speed required for a feed rate. The calibration equations below are for a direct visual comparison to the pump speed line/curve provided by the manufacturer. The operator will input the calibration results and there will be a line-to-line comparison between the calibration results and the manufacturer's curve. The following items explain this concept:

   The following adjustable set points shall be provided at the HMI:
   Y1: measure pump speed at calibration point 1
   X1: measured feed rate at calibration point 1
   Y2: measured pump speed at calibration point 2
   X2: measured feed rate at calibration point 2.

   The following 2-point linear equation shall be used to control the pump speed output:

Pump Speed = (Feed Rate * Slope) + Y1 – (X1 * Slope)

where Slope = [(Y1-Y2)/(X1-X2)]

Pump Sequence:

The Corrosion inhibitor pumps shall operate in a duty/standby strategy.

The duty/standby assignments shall be a manual selection via a software pushbutton at the HMI. The operator shall be prompted to assign a "Duty" pump, and a "Standby" pump. The pumps shall not automatically rotate unless there is a pump failure.

If the duty pump fails, the standby pump shall automatically take its place.

A failed pump shall be taken out of the sequence and marked as out of service.

When the pump is running, and the operator selects the standby pump as duty, the SCADA computer shall start the new duty pump and then stop the new standby pump (old duty) once the new duty pump is running.

Alarms / Monitoring:

Local (at pump):

Leak Alarm light (XA)
High Pressure Alarm Light (PAH)
VFD Fault Light (XA)
Speed Feedback (SI, 4-20mA = 0-100%)

SCADA PLC/OWS/OIT:

Run Confirm Status (YRI)
Pump in Auto (YCI)
Speed Feedback (SI)
Speed Control (SC)
VFD Fault (YFI)
Dosage above High Setpoint (XA)
Trim at Maximum (XA)
Leak (XA)
High Pressure (PAH)

LOOP 3651 CORROSION INHIBITOR CARRIER WATER LOW FLOW SWITCH

General: The carrier water flow is monitored and alarmed at SCADA.

Control:

Hardwired Interlocks:

None

Local:

None

SCADA PLC/OIT/OWS:

If any chemical pump is running and low water flow is detected, an alarm shall be triggered at SCADA. This alarm can be disabled in SCADA, if carrier water is not used.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

Low Flow Alarm (FAL)

LOOP 3710 CORROSION INHIBIOTR CARRIER WATER VALVE

General: Carrier water to facilitate delivery of corrosion inhibitor is controlled by a solenoid valve.

Control:

Local:

None

LCP-3210:

Open: When the OCA switch is in the "Open" position, the valve shall open.

Close: When the OCA switch is in the "Close" position, the valve shall close.

Auto: When the switch is placed in the "Auto" position, control shall be transferred to SCADA PLC/OWS/OIT.

SCADA PLC/OIT/OWS:

Manual: The valve can be opened and closed from the Open/Close pushbutton from SCADA PLC/OWS/OIT.

Auto: The valve shall open when any chemical pump is confirmed running.

Software Interlock:

None

Alarms / Monitoring:

Local:

None

SCADA PLC/OWS/OIT:

None

END OF SECTION 406196

SECTION 406263 - OPERATOR INTERFACE TERMINALS

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

1. Section includes operator interface terminals.

B. Related Requirements:

1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 DEFINITIONS

A. OIT – Operator Interface Terminal

1.4 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. Shop Drawings:

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.7 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.10 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.12 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.13 WARRANTY

A. Manufacturer's Standard Warranty: Manufacturer agrees to repair or replace components of computers that fail(s) in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 OPERATOR INTERFACE TERMINAL

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide the following:
      a. Rockwell Automation Allen-Bradley – Panel View Plus 7 Performance series.
      b. Substitutions: Not Permitted to match existing plant system platform.

B. General
   1. OITs are standalone devices with an integrated hardware / software platform to monitor / control a process through an interactive display.

C. Features
   1. Software

a. OITs shall be pre-packaged with all configuration and programming software necessary to perform functions as shown on drawings and within the specifications.
b. Integrated OIT software shall have the following features:
1) Trending
2) Data logging
3) Alarms
4) Graphic symbols
5) Animations
2. Hardware
a. Minimum one Secure Digital (SD) card slot

D. Communications
1. Ports
a. Minimum two 10/100MB Ethernet
b. Minimum one USB
c. Minimum one serial RS-232
2. Protocols
a. EtherNet/IP

E. Display:
1. 12" viewable as measured diagonally across screen
2. Display resolution shall be 1024 x 768.
3. Color Active Matrix TFT.
4. If additional keypad physical buttons are desired specify here.
5. Display shall support touch screen input.

F. Environmental:
1. Rating: OIT shall be rated to maintain the rating of the control panel it will be mounted on and meet the area classification.
2. Temperature: Operating temperature range of the OIT shall range 0 - 50 °C.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to control system architecture for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Operator Interface terminals will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 406263

SECTION 406343 - PROGRAMMABLE LOGIC CONTROLLERS

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

1. Section includes programmable logic controllers.

B. Related Requirements:
1. Section 406100 “Process Control and Enterprise Management Systems General Provisions” for submittal requirements.

1.3 DEFINITIONS

A. AO – Analog Output

B. AI – Analog Input

C. DI - Digital Input

D. DO - Digital Output

E. I/O – Input/Output

F. PLC - Programmable Logic Controller

1.4 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 INFORMATIONAL SUBMITTALS
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.7 CLOSEOUT SUBMITTALS
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.8 MAINTENANCE MATERIAL SUBMITTALS
   1. Provide a minimum of 25% spare I/O in PLC-CHEM. (Minimum of 2 Analog Inputs, 2 Analog Outputs, 8 Digital Inputs, and 4 Digital Outputs). These I/O points are required even if the point type is not being used. The spares shall be the same type of I/O modules supplied.
   2. Provide a minimum of 1 PLC I/O module for each type provided.
   3. Provide a minimum of 1 PLC Power Supply, CPU, and Communications module for each type provided.
   4. Reserve space within PLC-CHEM panel to accommodate two future I/O modules.
   5. Spare output points that require the use of an external relay shall be wired to the external relay.
   6. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall be Allen Bradley to match plant standard.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Configuration: Standalone programmable controller installed in the PLC-CHEM panel, located in the chemical building to control the Chemical Feed Building system(s).

2.2 COMPACT PROGRAMMABLE LOGIC CONTROLLER SYSTEM

A. Manufacturers:
   1. Provide all PLCs from a single manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third-party vendors will be acceptable.
   2. Manufacturers and their products are subject to compliance with requirements. Provide the following**:**
      a. Rockwell Automation Allen-Bradley – CompactLogix 5380 to match plant existing system platform.
      b. Substitutions: Not Permitted.

B. Provide compact PLC equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled I/O points.

C. Provide modular based but not chassis-based PLC System. Include individual modules for the processor, power supply, I/O, communication, etc., as needed to meet overall system requirements.

D. Provide products listed and classified by UL, CSA, or FM approval as suitable for purpose specified and indicated.

E. Provide equipment and devices designed for continuous industrial service. The system shall contain products of a single manufacturer and shall consist of equipment models that are currently in production.

F. Provide equipment designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory and resume normal operation without manually resetting when power is restored.

G. PLCs shall communicate between workstations, servers, instrumentation, switches, controllers, process actuators, etc., and the communications protocol shall be completely transparent from any HMI or OIT.

H. The PLC shall be capable of stand-alone operation in the event of failure of the communication link to an HMI or OIT subsystem.

I. Agency and environmental specifications:
   1. Electrical supply voltage to the PLC:
      a. 120 VAC, ±15 percent, 48 - 63 Hz.
      b. PLC system power supplies shall be fused for overload protection.
   2. Vibration:

a. 3.5 mm Peak-to-Peak, 5 - 9 Hz: 1.0G, 9 - 150 Hz.
b. Method of Testing: IEC 68-2-6 and JIS C 0911 standards for vibration.
c. System shall be operational during and after testing.
d. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:
1) Installed rating: DIN rail mounted PLC: 10 - 57 Hz, amplitude 0.075 mm, acceleration 25 - 100 Hz.
2) Panel or plate mounted PLC: 2 - 25 Hz, amplitude 1.6mm, acceleration 25 - 200 Hz.
3) In compliance with IEC 60068 and IEC 61131.

3. Shock:
a. 15G, 11 msec.
b. Method of Testing: IEC 68-2-27 and JIS C 0912 standards for shock.
c. System shall be operational during and after testing.
4. Temperature:
a. Operating Temperature: 0° to 60 °C (+32° to 140 °F).
b. Storage Temperature: -25° to 70 °C (-40° to 185 °F).
5. Relative Humidity:
a. Operating Relative Humidity: 10 to 95%, non-condensing.
6. Noise Immunity: Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.
7. Altitude:
a. Operation: 0 - 6,500 feet.
b. Storage: 0 - 9,800 feet.
8. Degree of protection: NEMA 1 (IP20).
9. All products shall have corrosion protection.

J. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:
1. Modules product type such as analog or digital.
2. Modules catalog number.
3. Modules major revision number.
4. Modules minor revision number.
5. Module manufacturer vendor.
6. Module serial number.

K. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations.

L. Central Processing Unit (CPU): CompactLogix 5380 Standard Controller to match existing plant standard. No equals shall be accepted.

M. Discrete Input & Output Modules:
1. General:
a. Digital input and output modules shall provide ON/OFF detection and actuation.
b. I/O count and type shall be as required to implement the functions specified plus an allowance for active spares, as noted below.
c. Modules shall be designed to be installed or removed while chassis power is applied.

d. Modules shall have indicators to display the status of communication, module health and input / output devices.
e. Each module shall have the following status indicators.
1) On/Off state of the field device.
2) Module's communication status.

2. Module Specifications – 120VAC Input Module
a. Nominal Input Voltage: 120VAC
b. On-State Current: 15mA @132V AC, 47 - 63Hz maximum.
c. Maximum Off-State Voltage: 20V.
d. Maximum Off-State Current: 2.5mA.
e. Number of Points per Card: 16.

3. Module Specification – 120 VAC Solid State Output Module
a. Each triac type discrete output shall have an associated interposing relay located in the same control panel. 120 VAC power for relay outputs shall be provided from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).
b. Output Voltage Range: 74 - 265 VAC, 47 - 63 Hz.
c. Output Current Rating:
1) Per Point: 0.5A maximum @ 30 degrees C; 0.25A maximum @ 60 degrees C; Linear Derating.
2) Per Module: 4A maximum @ 30 degrees C; 2A maximum @ 60 degrees C; Linear Derating.
d. Surge Current per Point: 5A for 43ms each, repeatable every 2s @ 60 degrees C.
e. Minimum Load Current: 10mA per point.
f. Maximum On-State Voltage Drop: 1.5V peak @ 2.0A and 6V peak @ load less than 50mA.
g. Maximum Off-State Leakage: 2.5mA per point.
h. Number of Points per Card: 16.

4. Module Specifications – Individually Isolated Relay Output Module
a. Output Voltage Range: 10 - 265 VAC, 47 - 63 Hz, 5 - 125 VDC.
b. Output Current Rating:
1) Per Point: 2.5A maximum.
2) Per Module: 16A maximum.
c. Power Rating (Steady State): 250 VA maximum for 125 VAC inductive output.
d. Maximum Off-State Leakage: 0 mA per point.
e. Configurable States:
1) Fault per Point: Hold Last State, ON or OFF.
2) Program Mode per Point: Hold Last State, ON or OFF.
f. Number of Points per Card: 8.

N. Analog Input & Output Modules:
1. General:
a. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.
b. Modules shall be designed to be installed or removed while chassis power is applied.
c. Modules shall have indicators to display the status of communication, module health and input / output devices.

d. Each analog module shall provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.
e. Analog modules shall be software configurable through the I/O configuration portion of the programming software.
f. Following status shall be capable of being examined in ladder logic:
1) Module Fault Word: Provides fault summary reporting.
2) Channel Fault Word: Provides under-range, over-range and communications fault reporting.
3) Channel Status Words: Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.
g. 24 VDC power for analog instrument loops shall be provided as a part of the system. 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. Field side of the 24 VDC power sources(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

2. Differential Analog Input Module:
a. Input Range: 0-20 mA.
b. Resolution: approximately 16 bits across range.
c. Input Impedance: Greater than 249 Ohms.
d. Overvoltage Protection: 8V ac/dc with on-board current resistor.
e. Normal Mode Rejection: 60 dB at 60 Hz.
f. Common Mode Noise Rejection: 120 dB at 60 Hz, 100 dB at 50 Hz.
g. Isolation Voltage:
1) Channel to Ground/Chassis - 100% tested at 1000 VDC minimum for 1s based on 250 VAC.
h. Provide individual isolators, in addition to the surge suppression devices specified, in the control panels listed in Section 406700 for all signals that enter the panel from outside the building. Substitution of isolated analog input cards to meet this requirement is acceptable. In addition, isolators shall be provided as shown on the drawings or for those signals that are coming from the following areas:
i. Number of Points per Card: 8.

3. Isolated Analog Output Current Module:
a. Output Current Range: 4 to 20 mA.
b. Current Resolution: 12 bits across 20 mA.
c. Open Circuit Detection: None.
d. Output Overvoltage Protection: 24V ac/dc maximum.
e. Output Short Circuit Protection: 20 mA or less (electronically limited).
f. Calibration Accuracy: Better than 0.1% of range from 4 mA to 20 mA.
g. Number of Points per Card: 8

O. Communication Ports:
1. Minimum of two 100/1G Ethernet
2. The CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

2.3 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Testing: Test programmable controller according to NEMA IA 2.2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, roofs, and rooms for suitable conditions where PLCs will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 CONNECTIONS

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Programmable logic controllers will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 SOFTWARE SERVICE AGREEMENT

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 406343

SECTION 406613 - SWITCHES AND ROUTERS

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

1. Section includes switches and routers.

B. Related Requirements:

1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Managed Ethernet Switch: Full-sized, fully configured unit for each type provided.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 INDUSTRIAL MANAGED ETHERNET SWITCH

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide the following.
      a. Allen-Bradley: Stratix 5410 series
      b. Moxa

c. Hirschmann
d. Substitutions: Or equal.

B. General:
1. Furnish a DIN rail mountable industrial managed Ethernet switch for connection to the network as shown in the Drawings and specified herein.
2. Furnish ethernet switches by the same manufacturer for the project, regardless of type.

C. Physical Features:
1. Minimum SFP slots: 2 x 100/1G SFP slots.
2. NOTE: Remove PoE requirement if you or the client do not need it. If you do need it be sure to check if it modifies the power input required for the switch.
3. Minimum copper ports: 6 x 100/1G ports.
4. Operating temperature: 0 to 130 °F.
5. Power: redundant 24VDC power input
6. Enclosure: Metal case.
7. Rating: UL Class 1, Division 2 Groups A, B, C, and D.

D. Network Features:
1. Layer 2 switching
2. Spanning Tree Protocol (STP)
3. Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w)
4. Full duplex on all port.
5. Auto negotiation and manual configurable speed and duplex.
6. Wire speed switching fabric.
7. IGMP snooping.
8. IGMP filtering.
9. Configuration password protected.
10. Configuration backup capability required.
11. SNMP V3.
12. Lock port function for blocking unauthorized access based on MAC address.

E. Additional Features:
1. Provide a dry contact rated for 120 VAC 5A to be used for common trouble alarm. The alarm shall be programmable. If the contact cannot use 120 VAC 5A, provide the necessary 24 VDC power from the PLC panel and provide interposing relays in the PLC panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, roofs, and rooms for suitable conditions where switches will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to control system architecture for tagging designations

3.4 FIELD QUALITY CONTROL

1. Switchers will be considered defective if it does not pass tests and inspections.
2. Prepare test and inspection reports in accordance with the following:
   a. Section 406100 – Process Control and Enterprise Management General Provisions
   b. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. For Managed Ethernet Switches:
      a. Enable the lock port function to block unauthorized access based on MAC address for each switch and router. All devices connecting to switch shall have static IP addresses assigned.
      b. Lock down all spare switch and router ports.

3.6 SOFTWARE SERVICE AGREEMENT

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 406613

SECTION 406619 - MEDIA CONVERTERS

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

1. Section includes media converters.

B. Related Requirements:
1. Refer to General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Copper to Fiber media converter.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 COPPER TO FIBER MEDIA CONVERTER

A. Manufacturers
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Moxa.
      b. Phoenix Contact.
      c. Red Lion.
      d. Substitutions: Or equal.

B. General:
   1. Provide a copper to fiber media converter as shown in the Drawings and specified herein.

C. Physical Features:
   1. RJ45 port: 10/100MB/1GB.
   2. Fiber uplink: 10/100MB/1GB (LC/ST/SC connectors).
   3. Fiber optics: Multi-mode capability as shown in the Drawings.
   4. Operating temperature: 0 to 130 °F.
   5. Power: 24 VDC.
   6. Enclosure: DIN-rail mountable.

D. Additional Features:
   1. The converter shall come equipped with a dry contact rated for 120 VAC 5A that shall be used for common trouble alarm. The alarm shall be programmable. If the contact cannot use 120 VAC 5A, provide the necessary 24 VDC power from the PLC panel and provide interposing relays in the PLC panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to control system architecture for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Media converters will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 406619

SECTION 406717 – INDUSTRIAL ENCLOSURES

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 requirements of industrial enclosures.

B. Related Requirements:
   1. Section 406733 for Panel Wiring.
   2. Section 406763 for Control Panel Mounted Uninterruptable Power Supplies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 INDUSTRIAL ENCLOSURES

A. Manufacturers
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Hoffman.
      b. Rittal.
      c. Saginaw.
      d. Substitutions: Or equal.

B. Freestanding and Floor-Mounted Vertical Panels:
   1. Furnish freestanding and floor-mounted vertical panels that meet the NEMA classification as shown on the drawings or specified herein. Construct panels of 12 gauge sheet steel suitably braced internally for structural rigidity and strength. Construct all NEMA 4X rated panels of Type 316 stainless steel, unless FRP is specifically indicated to be provided. For front panels or panels containing instruments, provide not less than 10 gauge stretcher-leveled sheet steel, reinforced to prevent warping or distortion.

C. Wall and Unistrut Mounted Panels:
1. Furnish wall- and Unistrut- mounted panels that meet the NEMA classification as shown on the Drawings or specified herein. Construct panels of not less than USS 14 gauge steel, suitably braced internally for structural rigidity and strength. Construct NEMA 4X rated wall mounted panels of Type 316 stainless steel, unless FRP is specifically indicated. For chlorine areas, use FRP panels. Provide a protective coating and sun shield to prevent discoloration and cracking for FRP panels located in direct sunlight.

D. Furnish the following panels:

PANEL SCHEDULE

Panel Name	Free Standing/Wall Mount	Minimum (inches)			Maximum (inches)		
		Height	Width	Depth	Height	Width	Depth
PLC-CHEM	Free Standing	72	36	24	84	42	24
Sodium Hypo Fill Station Control Panel	Wall Mount	36	30	12	42	36	12
Sodium Hypo Local Control Panel	Wall Mount	60	36	12	72	42	16
Caustic Soda Fill Station Control Panel	Wall Mount	24	20	8	30	24	12
Caustic Soda Local Control Panel	Wall Mount	36	30	12	42	36	12
Corrosion Inhibitor Fill Station Control Panel	Wall Mount	24	20	8	30	24	12
Corrosion Inhibitor Local Control Panel	Wall Mount	36	30	12	42	36	12
TCH-UPS	Wall Mount	36	30	12	36	30	16

2.2 ACCESSORIES

A. Environmental Controls:
1. Provide louvers, sun shields, heat sinks, forced air ventilation, and / or air conditioning units as required to prevent temperature buildup inside of panel. Regulate internal temperature of all panels to a range of 45 Deg F to 104 Deg F under all conditions. Do not compromise the NEMA rating of the panel under any circumstances.
2. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.
3. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.

4. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel, and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.
5. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.
6. Provide custom fabricated sun shields for all outdoor panels in accordance with the following requirements:
    a. Fabricate sun shields from minimum 12 gauge Type 316 stainless steel. Design, fabricate, install, and support shields to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.
    b. Depending on overall size, fabricate sun shields in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure.
    c. Do not attach sun shields directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces. Design and mount shields to provide a minimum 3-inch air gap all around the enclosure for air circulation and heat dissipation.
    d. Slope the top section of all sun shields at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, slope the top section downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures, slope the top section downward towards the back side of the enclosure.
    e. Incorporate a narrow and more steeply sloped drip shield segment at the front edge of the top section of all sun shields that sheds water away from the front of the enclosure and prevents it from dripping or running directly onto the front panel of the enclosure.
    f. Use continuous seam welds in sun shield fabrication and grind smooth.
    g. Smooth round or chamfer exposed corners, edges, and projections to prevent injury.
7. Provide an integral heater, fan, and adjustable thermostat for outdoor enclosures and enclosures located in unheated areas indoors or in areas subject to humidity and moisture to reduce condensation and maintain the minimum internal panel temperature. Mount unit near bottom of the enclosure with discharge away from heat-sensitive equipment. Heater shall be Hoffman DAH sized to the specific panel requirements, 120 Volt, 50/60 HZ or equal.

B. Nameplates:
1. Equip panels and panel devices with suitable nameplates to identify the panel and individual devices as required. Unless otherwise indicated, include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).
2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, furnish nameplates as 3/32-inch thick, black and white, Lamicoid with engraved inscriptions. Use black against a white background unless otherwise noted. Bevel and smooth edges of the. Nameplates with chipped or rough edges are not acceptable.
3. Mount or fasten cabinet mounted nameplates with epoxy adhesive or stainless steel screws.

4. For every panel, provide a panel nameplate with a minimum of 1-in high letters. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights, and meters.
5. Use single lamicoid nameplates with multiple legends for grouping of devices such as selector switches and pilot lights that relate to one function.

C. Corrosion Control:
1. Protect panels from internal corrosion by the use of corrosion-inhibiting vapor capsules. Size and quantity as necessary per manufacturer recommendations.
2. Manufacturer:
   a. Zerust VC.
   b. Hoffman Model AHCI.
   c. Or equal.

D. Data Pockets:
1. Provide a print storage data pouch on the outside of the control panel as indicated in the "I" drawings. The manufacture shall be Hoffman or equal. Storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.

2.3 GENERAL FINISH REQUIREMENTS

A. Descale, degrease, fill, grind and finish sections. Finish steel-fabricated enclosures with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which are applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels do not require a paint finish.

B. Grind smooth, sandblast and then clean with a solvent. Fill surface voids and grind smooth.

C. Immediately after cleaning, apply one coat of a rust-inhibiting primer inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. Apply final sanding to the intermediate exterior coat before top coating.

D. Apply a minimum of two coats of manufacturer's standard, flat light-colored lacquer, on the panel interior after priming.

E. Unless otherwise noted, finish exterior colors as ANSI 61 gray with a textured finish.

F. Finish products after assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 ADJUSTING

A. Adjust hardware and moving parts to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 406717

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SECTION 406733 - PANEL WIRING

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 requirements for internal wiring of control panels and consoles.

B. Related Requirements:
   1. Section 406717 for Industrial Enclosures.

1.3 ACTION SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 CONTROL PANEL - INTERNAL CONSTRUCTION

A. Internal Electrical Wiring:
   1. Provide stranded, type MTW interconnecting wiring with 600 volt insulation rated for not less than 90 degrees Celsius. Segregate wiring for systems operating at voltages in excess of 120 VAC from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Develop panel layout such that technicians shall have complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.
   2. For power distribution wiring on the line side of fuses or breakers, use 12 AWG minimum. For control wiring on the secondary side of fuses, use 16 AWG minimum. Utilize 18 AWG shielded, twisted pair cable insulated for not less than 600 volts for electronic analog circuits.
   3. Cover power distribution blocks with protective guards to meet “finger-safe” requirements of IP20.
   4. Route power and low voltage DC wiring systems in separate wireways. Cross different system wires at right angles. Separate different system wires routed parallel to each other by at least 6-inches. Terminate different wiring systems on separate terminal blocks. Do not fill wiring troughs to more than 60 percent visible fill.
   5. Terminations:

a. Terminate wiring onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.
   1) Multi-level terminal blocks or strips are not acceptable.
b. Arrange terminal blocks in vertical rows and separated into groups (power, AC control, DC signal). Provide each group of terminal blocks with a minimum of 25 percent spares.
c. Use compression type, fused, unfused, or switched terminal blocks. Use two terminals per point for discrete inputs and outputs (DI and DO) with adjacent terminal assignments. Wire all active and spare PLC and controller points to terminal blocks.
d. Use three terminals per point for analog inputs and outputs (AI and AO) per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. Wire all active and spare PLC and controller points to terminal blocks.
e. Use sleeve-type wire and tube markers with heat impressed letters and numbers.
f. Use only one side of a terminal block row for internal wiring. Field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free-standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.
g. Isolate circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Use an Allen Bradley Model 1492-H7 or equal. One isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.
h. Isolate all PLC discrete outputs to the field with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. Use an Allen Bradley 1492-H4 or equal.

6. Clearly identify wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection as such.
7. Wiring shall be clearly tagged and color coded. Tag numbers and color coding shall correspond to panel wiring diagrams and loop drawings prepared by the PCSS. Power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. Color coding scheme shall be in accordance with UL 508a.
8. Each field instrument furnished under Division 40 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. Instruments requiring 120VAC power shall be powered as shown on the drawings.
9. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. Side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.
10. Each panel shall have a single tube, LED light fixture, 20 Watt in size (minimum), mounted internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.
11. Each panel shall have an intrusion switch that trips an alarm in SCADA when the panel door is open. The switch shall be push-button type.
12. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate

cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.

13. Each panel shall have a convenience receptacle with an ethernet port mounted on the face of the panel. The port shall be a GracePort® or equal. Receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.
14. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.
15. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.
16. Microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS, refer 406763.
17. Each panel shall be provided with a circuit breaker to interrupt incoming power.
18. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 26.

B. Relays not provided under Division 26 and required for properly completing the control function specified in Division 40, Division 26 or shown on the Drawings shall be provided under this Section.

C. Orientation of devices including PLC and I/O when installed shall be per the manufacturer's recommendations. No vertical orientation of PLC racks shall be allowed unless specifically indicated by the manufacturer as an acceptable mounting alternative and also approved by the Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

END OF SECTION 406733

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SECTION 406763 - CONTROL PANEL MOUNTED UPS

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

1. Section includes control panel mounted uninterruptible power supply.

B. Related Requirements:
1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 SINGLE PHASE UPS - INTERNAL TO CONTROL PANELS

A. Manufacturers
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Allen Bradley 1609-D UPS.
      b. Falcon SSG Industrial UPS.
      c. Substitutions: Or equal.

B. System Description:
   1. Provide an industrially rated continuous-duty, on-line, solid state, line interactive, single-phase uninterruptible power system.
   2. UPS shall provide power conditioning and power backup for PLC, communications hardware, and other critical electronic loads as indicated on Drawings.
   3. UPS system shall consist of the following major components:
      a. Rectifier and battery charger.
      b. Inverter.
      c. Batteries.
      d. Maintenance bypass switch.
      e. Other features as described in this Section and as indicated on Drawings.

C. General Requirements:
   1. Battery protection shall be provided an internal circuit breaker disconnect.
   2. Current limiting circuitry shall protect inverter output under any load condition.
   3. AC output neutral shall be electrically isolated from UPS chassis. UPS chassis shall have an equipment ground terminal. Provisions for installation of a bonding connector shall be provided.
   4. UPS shall be suitable for installation in a UL508A listed panel.
   5. UPS shall be DIN rail mountable.
   6. UL recognized components for industrial applications in accordance with UL508 without derating.

D. Performance Requirements:
   1. Ratings:
      a. Output power: 1500 VA
      b. Battery runtime: 14 minutes at full-load, 34 minutes at half-load.
   2. Environment:
      a. Ambient temperature: 0 to 40 degrees C.
      b. Elevation: Up to 1000-ft above mean sea level.
      c. Relative humidity: 1 to 95 percent non-condensing.
   3. System Input - Primary source:
      a. Single input: Nominal Input Voltage: 120 VAC.
      b. Frequency: 45 to 65 Hz.
      c. Input Power Factor: 0.95 lag minimum, 50 to 100 percent load.
      d. Input Surge Withstandability: Per IEEE 587/ANSI C62.41. Category A and B, (6 kV).
   4. System Output:
      a. Nominal Output Voltage: 120 VAC
      b. Frequency: 60 Hertz plus or minus 3 Hertz.
      c. 100 percent load with 3:1 Crest Ratio
      d. Frequency Slew Rate: 1 Hz/second. (Adjustable at startup)
   5. AC to AC Efficiency (100 percent load @ rated PF): 88 percent online, 86 percent on battery.
   6. Acoustical Noise: Noise generated by UPS under normal operation shall not exceed 65 dBA (60 dBA typical) at one meter from any surface, measured at 25 degrees C (77 degrees F) and full load.
   7. EMI Suppression: UPS shall meet FCC Rules and Regulation 47, Part 15, Subpart J, for Class A devices.

E. Modes of Operation:
   1. UPS shall operate as a line interactive on-line, fully automatic system in the following modes:
      a. Normal: Critical load shall be continuously supplied with filtered and regulated AC power by inverter. Rectifier/battery chargers shall derive power from preferred AC source and supply DC power to inverter while simultaneously floats charge the batteries.
      b. Emergency: Upon failure of preferred AC power source, critical load shall continue to be supplied by inverter. Inverter power shall be supplied without switching from storage battery. There shall be no interruption to critical load upon failure or restoration of preferred ac sources. If AC source cannot be restored before battery discharges to its low voltage dropout value, UPS shall automatically shut itself down in an orderly manner.

c. Recharge: Upon restoration of AC source, rectifier/battery charger shall power inverter and simultaneously recharge batteries. This shall be an automatic function causing no interruption to critical load.

F. Rectifier/Charger:
1. Term rectifier/charger shall denote solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to inverter and for battery charging. Rectifier/charger shall be a solid-state SCR/IGBT power transistor type with constant voltage/current limiting control circuitry.

G. Inverter:
1. Inverter shall include all solid-state equipment and controls to convert DC power from rectifier/charger or battery to a regulated AC power for powering critical load. Inverter shall use Insulated Gate Bipolar Transistors (IGBTs) in a phase-controlled, pulse width modulated (PWM) design capable of providing the specified AC output.
2. Inverter shall be capable of supplying current and voltage for overloads exceeding 100 percent. Inverter is to provide 150 percent of full load for 30 seconds and 125 percent of full load for 2 minutes. A status indicator and audible alarm shall indicate overload operation.
3. Output voltage shall be maintained to within plus or minus 5 percent.
4. Output voltage total harmonic distortion (THD) shall not be greater than 5 percent at full load.

H. Batteries:
1. Batteries shall be High Temperature sealed, maintenance-free, high-rate discharge, lead-acid cells suitable for use indoors with no off gassing, or water addition requirements. Batteries shall not require special ventilation. Battery shall consist of one or more battery banks with number of cells required to meet requirements of rest of these specifications.
2. Battery Design Life: two - four years.

I. Controls and Monitoring:
1. Microprocessor-controlled circuitry: Fully automatic operation of UPS shall be provided through use of a microprocessor-based controller. Operating and protection parameters shall be firmware-controlled. Logic shall include system test capability to facilitate maintenance and troubleshooting. Startup, battery charging, and transfers shall be automatic functions.
2. Front Indicators: As a minimum, the following indicators shall be provided on UPS control panel:
   a. On-line (UPS is using utility power to power the load).
      1) In bypass mode.
      2) On battery.
      3) Overload.
      4) Replace battery / battery disconnected.
      5) Fault.
      6) Bar graph for utility voltage.
      7) Bar graph for battery.
   b. Front Panel Controls: As a minimum, the following controls shall be provided on UPS control panel:
      1) Power On/Off.
      2) Self-test.
      3) Alarm silence.

4) Cold start.
5) Load off.

c. Remote alarm and status indication: Isolated SPDT dry contacts shall be provided to indicate UPS status for remote monitoring. Contacts shall be rated for 250VAC @ 5A or 30VDC @ 5A Individual contacts shall be provided for separate annunciation of the following alarm and status conditions:
1) UPS on battery
2) UPS fault
3) UPS low battery
4) UPS on maintenance bypass

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, roofs, and rooms for suitable conditions where the UPS will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Control panel mounted UPS will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports in accordance with the following:
1. Section 406100 – Process Control and Enterprise Management General Provisions.
2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 SOFTWARE SERVICE AGREEMENT

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 406763

SECTION 406863 - CONFIGURATION OF HMI SOFTWARE

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. If referred to anywhere else in the project manual, AE or AESS services are those services specified in this Section.

B. Provide all programming, configuration, and related services required to achieve a fully integrated and operational system as specified herein. All equipment shall be controlled in full conformity with the Contract Drawings, process control descriptions, specifications, engineering data, instructions, and recommendations of the equipment manufacturer. Coordinate the control system for proper operation with related equipment and materials furnished by other suppliers under other Sections of these specifications and with related existing equipment.
   1. Provide reconfiguration of the existing plant HMI System Software and drivers for all equipment shown on the drawings, including equipment provided by vendor package systems.
   2. Provide configuration of Operator Interface Panels for all equipment shown on the drawings, including equipment provided by vendor package systems.
   3. Provide reconfiguration of any alarm dialer provided.
   4. Provide reconfiguration of the SCADA Historian Software.
   5. Provide configuration of system reports using the Reporting Software provided.
   6. Provide for and test communications and functionality between all connected devices (such as PLCs) and the HMI software packages, including devices supplied by others, as depicted on the system architecture drawings in order to provide a comprehensive working system of data collection, storage and reporting.

C. All work shall be coordinated with plant operating personnel to minimize impacts on daily operation. Delays caused for any reason shall be noted and formally submitted to the Engineer and the Owner in the form of a letter.

D. Related Requirements:
   1. Section 406866 Configuration of Controller Software

1.3 DEFINITIONS

A. AE – Applications Engineering

B. AESS – Applications Engineering System Supplier

1.4 COORDINATION MEETINGS AND WORKSHOPS

A. Refer to Section 406100. The meetings below are in addition to the meetings specified in that section.

B. Schedule and conduct a standards and conventions workshop. The purpose of this workshop shall be to review the standards, conventions, and methodologies that will be used to program and develop the programs (i.e., HMI and PLC databases, HMI graphics, and PLC programming, etc.) and will solicit Engineer and Owner's input. Submit an agenda with examples for items to be discussed at a client workshop.

C. Schedule and conduct a draft graphics review meeting. The purpose of this meeting shall be to present draft graphics for the Owner's and Engineer's review and feedback prior to creating the full set of graphics for review. For repetitive graphics such as graphics for multiple process trains, include an example of the first graphic only for discussion. Include discussion of process and overview displays, examples of pop-ups, trends, and system navigation tools. Expect major comments and incorporate any changes resulting from those comments.

D. Schedule and conduct a second graphics review meeting. The purpose of this meeting is to finalize the process of building the required HMI system. This meeting will be held after return of the draft graphics submittal and incorporation of comments. At this meeting, present the actual software displays, databases, security system, reports, and the like. The Owner will make comments on the system for incorporation prior to the factory test. Bring a working system to allow for a live demonstration of the graphics.

E. Schedule and conduct a historical data management and reports workshop. The purpose of this workshop shall be to discuss and solicit Engineer/Owner input for storage and management of historical data, format of daily, monthly and yearly reports, for the development of data entry templates, report formats and layouts, and user interface displays for accessing and generating reports. Bring examples of all these documents for review and discussion.

F. Schedule and conduct a factory testing coordination meeting, two weeks prior to factory testing. The purpose of this meeting is to discuss the specifics of the proposed tests and to provide a forum for coordinating the required factory testing.

G. Schedule and conduct a field-testing coordination meeting, two weeks prior to field testing. The purpose of this meeting is to discuss the specifics of the proposed tests and to provide a forum for coordinating the required field-testing.

1.5 ACTION SUBMITTALS

A. Provide all required submittals in accordance with Section 013000. The submittals listed below shall be provided as a minimum;
   1. System Standards and Conventions
   2. Operator Interface
   3. Controller Program
   4. Reports
   5. Historical Data Management

B. System Standards and Conventions Submittal

1. Following the standards and conventions workshop, submit the standards and conventions that will be used on this project. The submittal shall define, at a minimum:
    a. Graphic display standards, including color conventions, equipment symbols, display format, equipment control pop-up displays, trend displays, and display navigation. Include samples of each proposed type of graphic display (i.e., overview, detail, diagnostic, tabular, etc.)
    b. System naming conventions, such as graphic displays naming, database naming, tag names, and computer naming.
    c. System configuration, including network addressing and PLC/RTU addressing
    d. Alarm configuration standards, including priorities and logging
    e. Security configuration standards, including user groups and privileges
    f. PLC/RTU standard programming modules, including analog input scaling, flow totalization, equipment runtime, motor start/stop, valve open/close, and any other standard logic planned to be used.
2. To facilitate the Owner's future operation and maintenance, the submitted standards and conventions shall be used as the basis for programming and configuration of the system. System programming and configuration shall not begin prior to the System Standards and Conventions Submittal.

C. Operator Interface
1. Following the approval of the standards and conventions submittal, submit a draft of all proposed graphic displays, examples of each type of pop-up (faceplate) displays, and examples of trends. For those graphics which will be duplicated more than once for similar type of equipment, submit the graphics for the first equipment only.
2. Following the draft graphics review meeting and prior to the factory test, submit a ready-for testing version of all graphic displays. These graphics should be completely finished other than the incorporation of comments and changes resulting from testing.
3. Submitted graphic displays and trends shall be no less than 8.5 inches by 11 inches and in full color.

D. Historical Data Management
1. Following the Historical Workshop, submit all aspects of the historical data management system and shall include as a minimum the following:
    a. A complete listing of all signals to be collected and stored. This listing shall include data sampling rate and duration for which the data will be immediately accessible.
    b. Data reduction methods, rates, and duration data will be immediately accessible.
    c. Storage space requirements and supporting calculations.
    d. Description of historical database design, including data flow diagram, table definitions, procedures used, and queries used. Method of accumulating and displaying run times and flow totals shall be described. Method of interfacing to the reporting system shall be defined. Methods of handling Data Quality Flags shall be defined. Method of storing and displaying trending information shall be defined.
    e. Description of methodology for restoring data collected locally during times that the historical data management system is not available. Description of database failure and recovery, including data correction.
    f. Description of selecting only the active real-time data source for systems that are utilizing redundant data acquisition nodes.
    g. List of data source interfaces to be used with the system (for example, OPC, file collection, historian-historian collector, HMI applications, etc.)

E. Reports
   1. Following the Historical Workshop, submit all aspects of the reports generation system and shall include as a minimum the following:

F. A complete list of all reports to be developed.
   a. A complete listing of all signals to be reported, including calculated values.
   b. Description of reporting data storage design, including method data is polled and stored.
   c. Description of methodology for entering manual data and interfaced used.
   d. Procedures for recall, generation and printing of reports
   e. Printout of each report to be provided with details of each cell, where data comes from, and calculation of raw data.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. The system specified herein shall perform the following generalized functions:
   1. The system shall allow the operator to control equipment such as pumps and valves as shown on the Drawings and as defined in Section 406196 - Control Descriptions.
   2. Perform real-time process control, including proportional integral derivative control action, sequencing, process calculations, etc.
   3. Collect, calculate, and store accurate, reliable operating information for present and future uses.
   4. Assist remote site operating personnel by noting and communicating off normal operating conditions and equipment failures.
   5. Accumulate and store equipment running times for use in preventative maintenance.
   6. Provide color graphic displays and reports for use by the system operating and supervisory personnel.
   7. Provide trending for all analog values.
   8. Provide control system diagnostics.
   9. All process control functions including PID, calculations, sequencing, timing, etc., shall be done in the process controller. The HMI software shall perform the real-time database, report generation, graphic screens, program development, set point modification, data archiving, etc.
   10. The system shall allow the operator to manually control (by keyboard entry and mouse type pointing device) the status of pumps, valves, etc. (i.e., on off, open close, setpoint value, etc.) when viewing the appropriate graphic screen on the HMI.

3.2 GRAPHIC DISPLAYS - GENERAL

A. All displays shall contain and continuously update the displayed process variables, date and time of day. All process values shall be displayed in engineering units. All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers. All

process variables shall be displayed on their associated display(s) with correct engineering units. Process variables shall display their associated data quality flags.

B. All operator commands related to controlling field devices or system attributes shall require multiple keystrokes or mouse actions to protect against inadvertent operations. The operator shall receive confirmation of the selected point to be controlled, at which time a cancellation of the control can be affected.

C. Process graphic displays, shall be based on the P&ID's, site plan drawings, mechanical drawings and electrical drawings included in these Contract Documents. The graphic displays shall depict process flow streams, process structures, and all major items of process equipment and control devices in a schematic format.

D. All main graphical screens shall include a title bar, main graphic area, navigational buttons, and alarm summary bar. Title bar shall be displayed on the top of each screen and include display name, description and time/date. The main graphical area shall contain primary screen data in graphical format. Navigational buttons shall include a minimum of main menu, trends, main alarm summary, and security log in. The alarm summary bar shall display the last three valid alarms on the bottom of each screen.

E. Animation shall be provided to mimic level changes in tanks or vessels, and to mimic rotation of rotating equipment when running. Valve colors shall change when opened and closed.

F. Unless specifically noted, all timers, setpoints, alarm actuation levels, etc., shall be adjustable from the operator interface.

G. The system shall show field conditions with text that can alternate (i.e., OPEN/CLOSE, START/STOP, HIGH/LOW) and change color correspondingly. Field devices that are tri-state must be represented in three conditions.

H. Conditions in the field designated as alarm conditions shall report to the operator workstation, actuate an audible alarm, and provide a visual blinking image on the associated graphic page. All alarms and events shall be displayed on the screen and archived.

I. All interlocks that affect equipment operation shall be identified both by alarm and by HMI indication.

J. All analog inputs shall be checked for out of range (via high and low limit checks) and alarmed.

K. All process flow streams shall be labeled and color coded using the project color schedule in Division 09. All structures and equipment shall be identified by name and appropriate equipment and loop tags.

L. Color coding for equipment status and alarms shall be as follows:
   1. Green for on or open.
   2. Red for off or closed.
   3. Active, unacknowledged alarms are indicated by flashing amber.
   4. Active, acknowledged alarms are indicated solid amber.

M. Automatically record all alarm and events should any of the following sequences or events occur:

1. Date/Time entry.
2. Limit changes.
3. Any commanded or uncommanded change of any point.
4. Alarm conditions.
5. PLC activation or deactivation.
6. Operator login or logout activity.

N. There may be additional general programming requirements listed in Part 1 of the Section 406196 - Control Descriptions that impact the HMI configuration.

3.3 SPECIFIC GRAPHIC SCREENS

A. At a minimum, provide the following types of graphic screen indicated below.
1. Plant Overview screen shall be updated to include the new site plan representation, indicating the geographic location of each process, and each building. These can also be thought of as "index screens" if you are familiar with that terminology.
2. Main menu screen shall be updated to link to all new screens and process areas. The screen shall be a complete and logical listing of the names and number of all screens.
3. Overall chemical system process block flow diagram screen shall show all major processes in block form with flow arrows. Each block shall include a text description of key individual treatment processes. Navigational buttons to the individual treatment processes shall be performed by pressing on the text description.
4. Individual treatment process screens shall graphically screen key process variables and equipment. No operator entries shall be done from these screens. Individual process flow screens for each process shall include all process components, including tanks, pumps, flow meters, valves, mechanical devices, as well as manual shutoff and isolation valves. These diagrams shall be generally depicted from the P&ID's and there shall be at least 1 screen per P&ID on average.
5. Individual unit process screens depicted from the P&ID's are used for control and screen of each major item of process equipment, process variables, and control devices, including pumps, valves, etc. Navigational buttons shall consist of the P&ID's flow arrows to other individual unit processes. The unit process screens shall provide the ability for the operator to go to individual equipment popup screens. These diagrams shall be generally depicted from the P&ID's and there shall be at least 2 screens per P&ID on average.
6. Popup screens shall be provided for each piece of equipment to start/stop equipment, open / close valves, implement automatic control, adjust set points, establish and adjust tuning parameters, set alarm limits and initiate a sequence.
7. PLC system diagnostic screens, showing the operational status, and fault conditions of all PLC components, including processors, I/O modules, OIT's, power supplies and UPS units.
8. Communications diagnostic screens, showing the details of network status, communications status of all major components.
9. Maintenance screens shall screen the raw value for each analog and digital I/O point in the system. They shall also allow the operators/maintenance personnel to enter an override value for an analog point that is then used by the system instead of the value read from the input card / communications link.
10. Trend screens with the capability to screen up to eight, operator assigned, analog and/or digital process variables. Each analog value will be shown on a trend screen.

11. Main alarm summary screen shall screen the following information on each alarm: Time, tag name, description, alarm type, current value and status. An acknowledge alarm button shall acknowledge all new unacknowledged alarms. The acknowledged and unacknowledged alarms shall be different colors. Acknowledged alarms shall clear automatically after the condition is corrected.
12. Analog variable screens showing a tabular summary of all plant process variables, in operator assigned groupings.

3.4 SECURITY

A. The system shall be configured and implemented with security to prevent unauthorized access. The system shall allow authorized changes to system operation through defined user accounts and password verification.

B. Coordinate with Owner user account information, including login name and password for each account.

C. Security levels of "display only", "operator mode", "supervisor mode", and "engineer mode" shall be available through assignable passwords. On system startup, the "display only" security level shall automatically be entered. In the "display only" mode, information is available to be displayed on the screen, but no changes may be made. In the "operator mode", changes may be made to process set points, times, etc.; however, the overall control concepts may not be modified. In the "supervisor mode", all operator functions can be modified, and any special reports or critical process set points (data can be modified; however, the overall control concepts may not be modified). In the "engineer mode" level, all user modifiable parameters of the system shall be available for modification.

3.5 ALARM/EQUIPMENT STATUS REPORTING

A. The alarm log shall display all alarms as they occur. The alarm message shall include the time of occurrence, tag name, tag number, and whether it is a low, high, or failure alarm. When the point in alarm returns to normal, the time, point identification number, and return to normal shall be displayed. All reports shall include the plant equipment number of the associated device.

B. The equipment status shall be logged whenever a change in status occurs (i.e., start, stop). The equipment status log shall include the time, equipment name, tag number, and the particular change in status.

3.6 HISTORICAL DATA MANAGEMENT

A. The following features shall be provided for processing and storage of system historical data:
1. Each system point (analog or digital, real or pseudo) shall have the capability of being historically logged. A point shall have the capability of being deleted from historical log at any time. It shall be easy to add or delete system points using minimal keystrokes.
2. All process analogs and all flow totals and run time indications of all primary process equipment motors shall be sampled and stored in the historical data management system.

3. Data Processing: The real time instantaneous values shall be stored in a historical log file on the hard disk at defined sampling rates.
4. Data Correction: Historical data shall be manually modifiable by personnel with appropriate security levels. Such data shall be differentiated from actual monitored values on reports, in the database and in trends.
5. Data Quality: Data Quality flags shall propagate to the next higher level of the history based on user selectable percentage determining tolerance levels for averages and totals. If the percentage of suspect data exceeds the tolerance level, the suspect data flag propagates to the next higher level. Maximums and minimums shall be taken from good data.
6. Manual Input Data Handling: This data shall consist of additional values not obtainable by the system such as laboratory analysis for use in reports. All manually entered data shall be entered and stored in the appropriate engineering units. All data entered shall be displayed for con-firmation on the display prior to incorporation to the database.

3.7 REPORTS

A. Quantity and format of reports shall be determined at the historical data management and reports workshop and as a minimum shall include shift, daily, monthly and yearly reports.

B. The system shall be able to generate reports from on-line historical data files or prompt the user for the appropriate archived data files.

C. Reports shall be initiated automatically based upon time of day or manually upon operator request.

D. User interface displays for report generation shall be developed with easy recall of reports by entering time:day:year target values.

E. User interface displays shall allow the operator to define the destination of the report (e.g., display, printer, computer file, etc.) and when it is to be printed (e.g., immediately, on demand, or automatically at a specified time).

F. It shall be possible to print quality tags alongside the value.

G. Values for which there are no data available shall be identified with a special character. Thus, only values which are actually zero shall be printed as such.

H. Operational Report Types. The following operational report types shall be provided with the system:
   1. Daily Operation Summary Report
      a. The daily operation report shall summarize plant operation for the previous day. The printed information shall be the stored values (not averages) including scanned, lab, and manually entered data.
      b. The report format shall consist of the following: correct date, plant name, report name, page number, group headings, subheadings, point identifications, and engineering units.
      c. The daily minimum, average, maximum, and total where applicable shall also be calculated and printed for each point and stored.
   2. Monthly Operation Summary Report:

a. The monthly operation summary report shall summarize plant operation for the previous calendar month.
b. The report format shall be arranged so that the first several pages shall conform to the requirements of the state regulatory agencies and may be separated from the rest of the monthly operation report for transmittal to the regulatory agency.
c. The report format shall be similar to the daily operation summary report and shall consist of the following: month and year, plant name, report name, page number, group headings, sub-headings, point identifications, and engineering units.
d. Monthly minimum, average, maximum, and totals, where applicable, shall also be printed for each column of points printed.

3. Annual Operation Summary Report:
a. The annual operation summary report shall summarize plant operation for the previous calendar year. The report shall consist of scanned data, lab data, and manually entered data.
b. The format of the report shall be identical with the monthly operation summary report except for replacing month with year in the heading and replacing date with calendar month.

3.8 TESTING

A. Refer to Section 406121.

B. Supplement to Field Testing requirements
1. Prior to leaving the site, use the Owner's programming computer to monitor all PLC processors online, make on-line changes, upload and download the processor to ensure programming software version compatibility.
2. Loop Tuning - All PID control loops (single or cascade) shall be tuned following device installation but prior to commencement of the Functional Demonstration Test.
a. Optimal loop tuning shall be achieved either by auto-tuning software or manually by trial and error, Ziegler-Nichols step-response method, or other documented process tuning method.
b. Determine and configure optimal tuning parameters to assure stable, steady state operation of final control elements running under the control PID. Each control loop that includes anti-reset windup features shall be adjusted to provide optimum response following startup from an integral action saturation condition.
c. Tune all PID control loops to eliminate excessive oscillating final control elements. Loop parameters shall be adjusted to achieve a decay ratio of 1/4 or better. In addition, loop steady state shall be achieved at least as fast as the loop response time associated with critical damping.
d. Loop performance and stability shall be verified by step changes to setpoint in the field.
e. Submit loop tuning documentation as specified in Part 1 of this Section.

3.9 TRAINING

A. Refer to Section 406126 for general training requirements

B. Furnish training as shown in the table below.

Description	Minimum Course Duration (hours)	Maximum Number of Trainees per Course	Number of Times Course to be Given	Intended Audience
Onsite Training				
Control System Overview Seminar	2	2	1	Management
Operator Training (Pre start-up)	4	10	1	Operations
Operator Training (Post start-up)	2	10	1	Operations
Software Maintenance	2	4	1	Maintenance
System Reports and Historian	2	4	1	Maintenance

C. Control System Overview Seminar:
   1. Provide Control System Overview seminar for the Owner's personnel at the Owner's facility. The objective of this seminar is to provide personnel with an overview understanding of the Control System. The seminar material shall be targeted to the Owner's management, engineering, and other non-operations personnel. The seminar shall include, but not limited to, the following:
      a. An overview of the Control system explaining how the hardware and software supplied under this Contract is used for the operation and control of the facilities.
      b. A block diagram presentation of the Control system showing how and what information flow within the system and what each functional unit does.
      c. An explanation of the operator interfaces including a demonstration of how to use an operator's workstation to monitor, control, navigate, display trends, and all other operational features of the system. Discussion of process control of individual processes shall be addressed outside of this course.
      d. A walkthrough of the installed system explaining each of the items covered in the functional units' discussion. The features and functions of operator controls and interfaces shall be discussed.

D. Operator Control System Training (pre- or post- start-up):
   1. Operator training shall cover plant operation with the control system and use of the HMI display screens, including at a minimum all the following items:
      a. Basics of HMI control and navigation.
      b. Alarming and Interlocks.
      c. Auto functionality of automated processes and HMI control.
      d. Failure modes of equipment and operator responses.
   2. Minimum of two operator training sessions (Pre-Startup) for operators shall be held 1 week before system startup. The pre-startup training shall make use of the Simulator specified in this project. Additional one or two operator training sessions (Post-Startup) for operators shall be held one week after system startup.
   3. Operator training shall be held at the convenience of the Owner. This training may be held during the day, late at night, or very early in the morning to accommodate the Owner's shift schedule.
   4. Operator training shall be introductory in nature during pre-startup training and more in-depth and detailed during post-startup training.
   5. At a minimum, the following teaching aids shall be available for distribution during Operator training sessions:
      a. Preliminary O&M Manuals (pre-startup); Final O&M Manuals (post-startup).
      b. P&IDs.

c. Daily syllabus.

6. Fifty percent of all Operator training shall be "hands on" utilizing the installed Control System to the fullest extent possible. Confirm the operability of the Control System before commencing training. Training performed using a non-functioning Control System shall be rejected and repeated.

E. Software Maintenance:
   1. Provide training of how to back-up PLCs, HMIs, OITs, and any other software in this system.
   2. Provide training on all aspects covered in the O&M Software Maintenance Manuals.
   3. Provide training on PLC program structure, HMI configuration structure, tips in how to edit programming code, and other items which will supplement the maintenance staff's ability to edit and maintain the programs.

F. Historian and System Reports:
   1. Provide training of how to run the reports, how to manually enter data, and how to print and reprint the reports.
   2. Provide training on how to execute data queries that are outside of those defined in the reports.
   3. Provide training on Historian configuration, report configuration, database maintenance and backup, and repair of failed reports.

END OF SECTION 406863

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SECTION 406866 - CONFIGURATION OF CONTROLLER SOFTWARE

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. If referred to anywhere else in the project manual, AE or AESS services are those services specified in this Section.

B. Provide all programming, configuration, and related services required to achieve a fully integrated and operational system. All equipment shall be controlled in full conformity with the Contract Drawings, process control descriptions, specifications, engineering data, instructions, and recommendations of the equipment manufacturer. Coordinate the control system for proper operation with related equipment and materials furnished by other suppliers under other Sections of these specifications and with related existing equipment.
   1. Provide configuration of the PLC provided for all equipment shown on the drawings, except for controls equipment shown being provided as part of a vendor package system.

C. All work shall be coordinated with plant operating personnel to minimize impacts on daily operation. Delays caused for any reason shall be noted and formally submitted to the Engineer and the Owner in the form of a letter.

D. Related Requirements:
   1. Section 406863 – Configuration of HMI Software.

1.3 DEFINITIONS

A. AE – Applications Engineering

B. AESS – Applications Engineering System Supplier

1.4 COORDINATION MEETINGS AND WORKSHOPS

A. Refer to meeting requirements of section 406863.

1.5 ACTION SUBMITTALS

A. Controller Program Submittal
   1. For each controller, submit the following using the controller manufacturer's built in printing functions. Electronic submission of Adobe Portable Document Format ("pdf")

files in lieu of paper submittals is acceptable. Review will be for general program organization, level of documentation, and overall programming standards (basic pump and valve control, for example). The review will not attempt to confirm the logic works correctly for every loop.

a. PLC programs showing ladder logic, function block, high level language or another controller language used. Include individual rung, network, and/or command descriptions with abundant comments to clearly identify function and intent of each code segment. Each logic segment shall be clearly presented, the function of each timer described, the purpose of each subroutine call labeled and defined, etc. Program documentation shall be sufficiently clear to allow determination of compliance with the process control requirements included in the control descriptions and with the Drawings. The submittal shall demonstrate that all logic provided under this project follows the same structure and format and reflects a common programming approach.
b. Submit a memory usage report for the controller. This report shall indicate total memory capacity and unused memory capacity.
c. Submit cross reference index of I/O allocation and controller memory address. Every physical I/O point as well calculated or virtual I/O required for the implementation of the process scheme shall be included.

2. Submit details of control system communication. Submit a "memory map" or other means showing which signals are exchanged between PLCs. Also submit a HMI tag database showing all signals exchanged between the PLCs and HMI. Any specific communication block memory addresses shall be defined.

B. Submit all electronic files associated with the controller such that the Owner and Engineer can open a complete copy of the controller program using the controllers native programming package.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONTROLLER PROGRAMS

A. All applications programs shall be developed in a structured manner and shall follow an intuitive arrangement so that an instrumentation technician with basic programming knowledge will be able to understand. Programs shall utilize standard program templates or subroutines for repetitive logic such as equipment control, flow total calculations, equipment runtime calculations.

B. Make changes to the application programs and software configuration, based on comments during the submittals, the factory tests, the field tests, and during the commissioning process to meet the design intent, at no additional cost to the Owner.

END OF SECTION 406866

SECTION 407000 - INSTRUMENTATION FOR PROCESS SYSTEMS

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.

B. Refer to Section 406100 Process Control and Enterprise Management Systems General Provisions.

1.2 SUMMARY

A. Section includes the general requirements for furnishing, installing, and servicing PCSS provided instruments.

B. Related Requirements:
   1. Refer to individual instrument specifications.

1.3 DEFINITIONS

A. PCSS – Process Control System Supplier as defined in Section 406100 – Process Control and Enterprise Management System General Provisions

1.4 ACTION SUBMITTALS

A. Submit complete documentation of all field instruments using ISA-TR20.00.01-2001 (updated in 2007) data sheet formats. Submit a complete Bill of Materials (BOM) or Index that lists all instrumentation equipment. The list shall be sorted by Loop Number.

B. Submit separate data sheets for each instrument type including:
   1. Plant Equipment Number and ISA tag number per the Drawings.
   2. Product (item) name used herein and on the Drawings.
   3. Manufacturer's complete model number.
   4. Location of the device.
   5. Input - output characteristics.
   6. Range, size, and graduations in engineering units.
   7. Include construction details, material descriptions, dimensions of individual components and profiles.
   8. Instrument or control device sizing calculations where applicable.
   9. Indicate which instruments will be provided with certified calibration data (i.e., all flow metering devices) as part of O&M manual.
   10. Include rated capacities, operating characteristics, electrical characteristics and furnished specialties and accessories Two-wire or four-wire device type as applicable.

11. Indicate which instruments will be provided with manufacturer's maintenance services if specified.

C. Instrument Vendor Shop Drawings:
1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of instrument.
4. Include diagrams for power, signal, and control wiring.

D. Submit catalog cuts for all instruments. Submit descriptive literature for each hardware component, which fully describes the units being provided.

E. Submit index and data sheets in electronic format on 8-1/2" x 11" formats. Electronic format shall be in Microsoft Excel or Word. Submit electronic copy on DVD disk or USB thumb drive.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding closeout submittals for instruments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Refer to individual instrument specifications for spare parts requirements.

B. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for PCSS requirements regarding submission of maintenance materials

1.8 QUALITY ASSURANCE

A. Refer to individual instrument specifications for quality assurance requirements as well as which specific instruments require manufacturer's start-up and training services.

B. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for overall quality assurance requirements for PCSS scope of work.

PART 2 - PRODUCTS

2.1 INSTRUMENT TAGS

A. A permanent PVC or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section and related sections. Equipment shall be tagged before shipping to the site.

B. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.

C. All supplied instrument transmitters and instrument transmitter elements shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via non-corrosive zip tie to a non-removable part of the device. The tag size shall be a minimum of 1inch H x 3”W. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.

PART 3 - EXECUTION

3.1 GENERAL

A. See execution requirements in Section 406100 – Process Control and Enterprise Management Systems General Provisions.

B. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

3.2 INSTALLATION

A. See installation requirements in individual specification sections.

END OF SECTION 407000

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SECTION 407179 - FLOW SWITCHES

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 flow switches.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish one flow switch from the same product run that matches the product installed and is packaged with protective covering for storage and identified with labels describing contents.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 VANE ACATUATED FLOW SWITCHES

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide the following Provide one of the following:
      a. Magnetrol - F50 and F10.
      b. Dwyer - Flotect Series.
      c. Substitutions: Or equal

B. Type
   1. Vane or disc actuated flow switch.
   2. Switch magnetically linked to vane or disc actuated mechanism

C. Function/Performance:
   1. Output: Form 2C (DPDT) snap action, hermetically sealed switch, rated for 10 amps, 125/250 volts AC.

D. Physical:
   1. Provide flow body for switches for process pipe sizes of 3/4 to 1-1/2 inches. Mount switches directly on process pipe for pipe sizes greater than 1-1/2 inch. Provide mounting assembly for pipe.
   2. Provide Type 316 stainless steel flow body and all wetted parts.
   3. Switch housing: NEMA 4X (IP65) and where installed in hazardous areas, approved for Class I, Division 1, Groups C and D (EEx d IIc T6).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping, walls, floors, and roofs for suitable conditions where flow switches will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with manufacturer’s instructions for installation of each flow switch.

B. Comply with NECA 1.

C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designation.

3.4 FIELD QUALITY CONTROL

A. Perform any tests and inspections recommended by the manufacturer.

B. Flow switches will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Perform installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407179

SECTION 407213 - ULTRASONIC LEVEL METERS (CONTINUOUS AND POINT TYPE)

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 ultrasonic level meters.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Ultrasonic Gap Switch: One full-size unit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

PART 2 - PRODUCTS

2.1 ULTRASONIC GAP LEVEL SWITCH

A. Level Switch- Point Level Ultrasonic Gap Probe:
   1. Manufacturers:
      a. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
         1) Endress & Hauser.
         2) Magnetrol.
         3) Siemens Automation Technology; Siemens AG Industry Sector.
         4) Substitutions: Or equal.
   2. Type: Housing: Heavy duty cast aluminum NEMA 4X with 120 VAC contact outputs. Locate the housing/electronics outside tank, channel or containment area
   3. Operation: Purpose - To detect liquid at a predetermined level with contact at the gap area and actuate an alarm. Operating Principal -To actuate the control relay when the returning echoes between the sensor and the product level are not detected. The minimum distance between the sensor and maximum product level is determined by the ringing time of the sensor.
   4. Functional: Output: DPDT Contacts, 7 Amps, 120 VAC

5. Power Requirements: 120 VAC, 60 Hz.
6. Physical: Probe -PFA, or Type 316 SS; Mounting - 2" 150 # flange or NPT fitting. Probe length to suit activation point. Multiple gap probe for multiple level point detection. Provide flanges for probes mounted on tanks. Provide correct length probes from housing/electronics to active right at the bottom of the tank, channel or containment area or right above suction line of pumps. The correct lengths determined during the construction phase.
7. Performance: Sensitivity- response time of 2 seconds and a repeatability of 0.0625 inch.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and roofs for suitable conditions where the ultrasonic level meter will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Ultrasonic level meters will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the unit. Training shall be provided in accordance with section 406126 – Testing.

END OF SECTION 407213

SECTION 407223 - RADAR LEVEL METERS

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 radar level meters.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Non-Contact Radar Level Measurement Device: One Unit

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of the radar level meter that fail(s) in materials or workmanship within the specified warranty period.
   1. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 NON- CONTACT RADAR-LEVEL MEASUREMENT DEVICE

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide the following
      a. VEGA Americas, Inc.
      b. Substitutions: Or equal

B. Type:
   1. Non-contact, microwave type level meter.
   2. Low 6.3 GHz radar frequency for continuous level measurement of liquid, slurry and sludge processes in storage vessels that may be turbulent, have heavy vapors and foaming conditions in nominal pressure and temperature.
   3. Antenna: Rod, Horn, Parabolic, or Encapsulated.

C. Function/Performance:
   1. Measuring Range: Range suitable for the installation indicated,

2. Accuracy: Plus or minus 0.32 inches (8 mm).
3. Operating Temperature: -40 to 149 degrees F (-40 to 65 degrees C).
4. Output: Isolated 4-20 mA output.
5. Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument Device Schedule.
6. Diagnostics: On-screen instructions and display of self-diagnostics.

D. Physical:
1. Antenna: PVDF, Type 316 stainless steel, Hastelloy C or other material depending upon its compatibility to the process in which it is measuring.
2. Provide with a minimum Class 150 pound (DN 80, PN16) mounting flange to match vessel flange size, material and class when mounted on vessel.
3. NEMA 4X (IP66) housing.
4. Power Requirements: 120VAC power.
5. Remote Display: Digital indicator displaying level or volume in engineering units or percent, as indicated on the Drawings or in the Instrument List. Display unit used to remotely program the transmitter.

E. Accessories Required:
1. Where required for calibration/programming, provide a hand-held programmer

F. Manufacturer Start-up and Training services:
1. Provide manufacturer's start-up and training services as specified in the start-up and training services paragraph.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Radar level meters will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter. Training shall be provided in accordance with 406126.

END OF SECTION 407223

SECTION 407276 - LEVEL SWITCHES

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 level switches.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Float Switch: Full-size units equal to 20 percent of quantity installed for each size indicated, but no fewer than one unit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 FLOAT SWITCHES

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Contegra FS 90.
      b. Siemens Water Technologies Model 9G-EF.
      c. Substitutions: Or equal.

B. Type:
   1. Mercury free ball float switch.

C. Function/Performance:
   1. Differential: Less than 8 inch.
   2. Type of Switch: SPDT snap switch
   3. Switch Rating: 1 amps at 120 VAC or 100 VA @ 120 VAC.

D. Physical:
   1. Float: Type 316 stainless steel, Teflon or non-stick coating, minimum 5 in diameter.
   2. Totally encapsulated switch.

3. Cable shall be heavy-duty, PVC or equivalent jacketed integral to float.

E. Options/Accessories Required:
1. Provide chemical-resistant hardware.
2. Lead wire shall be a waterproof cable of sufficient length so that no splice or junction box is required in the vault.
3. Provide chemical-resistant weatherproof junction box outside the sump pit with terminals for all floats and tapped as required for conduit connections.
4. Provide mounting equipment as shown on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine installation area for suitable conditions where the float switches will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Level switches will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor. Training shall be provided in accordance with section 406126.

END OF SECTION 407276

SECTION 407313 - PRESSURE AND DIFFERENTIAL PRESSURE GAUGES

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 pressure and differential pressure gauges.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407000 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. One pressure gauge

1.8 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

1. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:
1. Ametek US Gauge.
2. Ashcroft.
3. Weksler.
4. Or equal

B. Type: Differential or Gauge - Bourdon tube actuated dial face pressure gauge.

C. Dials:
1. Nominal Diameter: 4-1/2 inches. Minimum 4 inches.
2. Face: White, laminated plastic dials with black graduations.
3. Scale: Extend over arc not less than 200 and not more than 270 degrees.
4. Ranges and Graduation Units: As indicated on Instrument Schedule.

D. Cases:
1. Liquid filled.
2. Material: Phenolic or Type 316 stainless steel.
3. Provide removable rear plate.
4. For gauge pressure, vented case for temperature/atmospheric compensation
5. Windows:
   a. Material: Clear acrylic or shatterproof glass.
   b. Thickness: 1/8 inch.
   c. Provide gasket.

E. Connection:
1. Location: Bottom.

2. Socket:
   a. 1/2-inch NPT male thread.
   b. Material: Brass forging.
   c. Extend minimum 1-1/4 inches below gage cases.
   d. Provide wrench flats.
3. Mounting: Stem or surface.

F. Measuring Element:
1. Bourdon Tubes:
   a. Material: Stainless steel, to brass socket.
   b. Provide welded, stress-relieved joints.
2. Movement:
   a. Material: Stainless steel.
3. Accuracy:
   a. Comply with ASME B40.100.
   b. Plus and minus 1.0 percent of full-scale range.

G. Adjustment:
1. Provide for zero-reading adjustment.
2. Adjusting Screws: Accessible from rear of case without need for disassembly.

H. Accessories:
1. Pressure Snubber:
   a. Material: Type 316 stainless steel.
   b. Provide isolation valve.
2. Shutoff Cocks: Furnished by gage manufacturer.
3. Special scales: Engineer reserves the right to require special scales and/or calibration if the manufacturer's standard is not suitable for the application.
4. Gauges listed as liquid filled in the instrument device schedule shall be liquid filled at the factory.
5. For each differential pressure switch, provide a three-valve manifold. The manifold shall be Type 316 stainless steel. Manifolds shall be D/A Manufacturing or Anderson Greenwood.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 FIELD QUALITY CONTROL

A. Prepare test and inspection reports.

3.4 MAINTENANCE SERVICE

A. Not Required

3.5 DEMONSTRATION

A. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

END OF SECTION 407313

SECTION 407346 - LOAD CELLS

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 load cells.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 - Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Load Cells: Full-size units equal to 33 percent of quantity installed for each size indicated, but no fewer than 1 unit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 LOAD CELLS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Rice Lake 420 Plus Digital Weight Indicator
      b. Substitutions: Or equal.

B. Performance Requirements:
   1. Capacities and Characteristics:
      a. Weight Indicator / Transmitter:
         1) Type:
            a) Microprocessor-based transmitter.
         2) Function/Performance:
            a) Measurement Rate: 15 updates per second.
            b) Resolution: Internal resolution of 300,000 counts. Display resolution of 100,000 counts.
            c) Output: 4 to 20 mA proportional to the calibrated range.
            d) Display: LED digital display. Weight indication to be selectable in pounds or kilograms.

e) Physical:
- Suitable for surface mounting.
- NEMA 4X (IP66) enclosure.
- Power Requirements: 115 VAC/60 Hz.

b. Weigh Modules:
1) Type:
a) Module ready for bolt-in place installation, including a single end beam load cell.
b) Temperature compensated full bridge transducer.
2) Function/Performance:
a) Range: Range as indicated in the Instrument Device Schedule.
b) Total Error: plus or minus 0.02 percent of full scale.
c) Operating Temperature: -10 to 40 degrees C temperature compensated range.
d) Safe Load: 150 percent of full scale.
3) Physical:
a) The load cell shall be hermetically sealed (IP68).
b) The module shall be compatible with the chemical being measured.

2. Accessories Required:
a. Summer with inputs for the number of weigh modules indicated on the Drawings or in the Instrument Device Schedule.
b. Cables for installation between weigh modules and the summer shall be factory installed to the load cell. Length to be as required by installation indicated on the Drawings.
c. Load cells shall be fitted with adapters for conduit connections.
d. Cable shall be provided for installation between the summer and the transmitter. Length shall be as required by installation indicated on the drawings up to 100 feet (30 m).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area around the intended installation site for suitable conditions where Load Cells will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Load cells and indicator will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter. Training shall be provided in accordance with section 406126.

END OF SECTION 407346

SECTION 407363 - DIAPHRAGM SEALS

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 diaphragm seals.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 DEFINITIONS (NOT USED)

1.4 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.6 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.7 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.9 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 DIAPHRAGM SEALS – THREADED

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Rosemount
      b. Ashcroft
      c. Ronnigen-Petter Company
      d. Siemens
      e. Substitutions: Or equal.
   2. Mounting:
      a. Directly to pressure gage socket.
   3. Wetted Parts and Bolt Materials: Corrosion resistant to process fluid.
   4. Provide fill/bleed screw for filling of diaphragm seal.
   5. Instrument Connection: NPT, 1/4 inch.
   6. Process Connection: NPT, 1/2 inch.
   7. Flushing Connection: NPT, 1/4 inch.

8. Working Pressure Rating: Pipeline working pressure.
9. Calibration: Provide cleanout ring to be removed for recalibration or cleaning, without loss of filling liquid or change in calibration.

2.2 SOURCE QUALITY CONTROL

A. Section 014000 – Quality Requirements: Requirements for testing, inspection, and analysis.

B. Diaphragm Seals:
1. Factory-assemble, fill, and calibrate entire assembly, including gage prior to shipment.
2. Field filling is not acceptable.

C. Provide shop inspection and testing of completed assembly.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 FIELD QUALITY CONTROL

A. Diaphragm seals will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 MAINTENANCE SERVICE

A. Not Required.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407363

SECTION 407506 - SINGLE PARAMETER ANALYZER TRANSMITTER

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 analyzer transmitters for both configurations as indicated on the Drawings.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Single Parameter Transmitter: One full-size unit.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 SINGLE-PARAMETER ANALYZER TRANSMITTER

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following.
      a. Hach – SC200.
      b. Substitutions: Or equal

B. Type:
   1. Microprocessor-based, intelligent transmitter compatible with a minimum of sensor (digital or analog) inputs.

C. Function/Performance:
   1. Accuracy: ± 0.1% of span.
   2. Repeatability: ± 0.05% of span.
   3. Response Time: 60 seconds to 90% of value on a step change.
   4. Temperature Compensation: Compensation over entire temperature range of the instrument.
   5. Environmental Conditions: -10 to 55 °C and 5 to 95% relative humidity.
   6. Hardwired Outputs:
      a. Minimum: (2) 4-20mA outputs.

b. Minimum: (4) 120VAC, 5A, configurable relays.

7. Network Communications:
   a. Modbus RS-232
   b. Modbus rs-485
   c. Profibus DP
8. Diagnostics: On screen instructions and display of self-diagnostics.

D. Physical:
1. Transmitter shall be suitable for surface or pipe stand mounting.
2. Enclosure shall be NEMA 4X (IP65).
3. Power Requirements: 120VAC powered.

E. Accessories:
1. Provide sensor connection cable and plug between the transmitter and the analyzer sensor for rapid attachment and exchange of sensor.
2. Provide connection box for analyzers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, and roofs for suitable conditions where the transmitter will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Single parameter analyzer transmitter will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407506

SECTION 407513 – pH / ORP ANALYZERS

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 pH-ORP analyzer.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.
   3. Section 407506 – Single Parameter Analyzer Transmitter.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 pH FIELD ANALYZERS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. HACH – pHD SC Sensor.
      b. Substitutions: Or equal.

B. Sensor:
   1. Type:
      a. pH-sensitive glass membrane electrode, double or triple-junction reference electrode and ground electrode with integral preamplifier.
      b. For flow through application as indicated on the Drawings or in the Instrument Device Schedule.

2. Function/Performance:
   a. Range: 0 to 14.
   b. Temperature Compensation: Temperature element integral to sensor for temperature compensation.
3. Physical:
   a. Flat glass or shrouded pH electrode.
   b. Sensor assembly constructed of PVDF, Tefzel, or similar material.
   c. Sealed electrodes.
4. Accessories Required:
   a. Manufacturer's cable for connection of sensor to transmitter. Length as required by installation indicated on Drawings.
   b. One year's supply of consumables for calibration.
   c. Handrail mounting kit where indicated on the Drawings to be required.

C. Transmitter:
1. Include a compatible transmitter that is by the same manufacturer as the instrument and is a single-parameter analyzer transmitter as specified in Section 407506, as required by the instrument device schedule.

D. Manufacturer Start-up and Training services:
1. Provide manufacturer's start-up and training services as specified in the “Manufacturer Start-up and Training Services” Article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. pH-ORP analyzers will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter. Training shall be provided in accordance with Section 406126.

END OF SECTION 407513

SECTION 407521 - CHLORINE ANALYZERS

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 chlorine analyzer.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions.
   2. Section 407100 – Instrumentation for Process Systems.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.9 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.10 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 CHLORINE RESIDUAL ANALYZER - COLORIMETRIC

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. HACH Model CL17sc Chlorine Analyzer.
      b. Substitutions: Or equal.

B. Type:
   1. Microprocessor based electronic transmitter/converter flow-through sample cell.
   2. Colorimetric chlorine analyzer for monitoring of free or total residual chlorine.
   3. Must use colorimetric method for measuring free or total chlorine. Instrument chemistry will employ N, N-diethyl-p-phenylenediamine (DPD) method.
   4. Other methods of chlorine measurement such as amperometric, potentiometric, and iodometric that employ electrodes or other electrochemical techniques are not acceptable.

C. Function/Performance:
   1. ± 5% of reading or ±0.04 mg/L (ppm), whichever is greater from 0 to 5 mg/L as Cl2; +/- 10% from 5 to 10 mg/L as Cl2
   2. Resolution: 0.01 mg/l.
   3. Range: 0-10 mg/l.
   4. Environmental Conditions: The instrument shall operate over an ambient temperature range of 2-50 degrees C.

5. Output: Isolated 4-20 mA output and 3 programmable alarm contacts rated for 5A at 230 VAC.
6. Display: Dot matrix or LCD type displaying chlorine residual in ppm.
7. Diagnostics: On screen instructions and self-diagnostics.
8. Response: 90 percent of full scale within 2 minutes.
9. Physical: Analyzers shall be suitable for surface mounting.
10. Power Requirements: 120 VAC/60 Hz.
11. Electronics enclosure shall be NEMA 4X.
12. Accessories Required:
    a. Standpipe Installation kit as indicated in the Drawings
    b. Provide one year's supply of manufacturer recommended consumables including, but not limited to, reagents and annual maintenance kits.
    c. Provide 2 spare fuses (if not included as part of a maintenance kit).

D. Manufacturer Start-up and Training services:
1. Provide manufacturer's start-up and training services as specified in the start-up and training services article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors for suitable conditions where the analyzer will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Chlorine analyzers will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter. Training shall be provided in accordance with Section 406126.

END OF SECTION 407521

SECTION 407569 ORTHOPHOSPHATE ANALYZERS

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 analyzer for monitoring of orthophosphate in water.

B. Related Requirements:
   1. Section 406100 “Process Control and Enterprise Management Systems General Provisions.”
   2. Section 407100 “Instrumentation for Process Systems.”

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Refer to Section 406100 “Process Control and Enterprise Management Systems General Provisions.”

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 407000 – Instrumentation for Process Systems.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

C. Shop Drawings:
   1. Refer to Section 407000 – Instrumentation for Process Systems.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions for any PCSS requirements regarding informational submittals for instruments.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Refer to Paragraph 2.1.C.9 in Part 2 of this Section.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.10 FIELD CONDITIONS

A. Refer to Section 406100 “Process Control and Enterprise Management System General Provisions.”

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 Phosphate Analyzer

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. SWAN AMI Phosphate-II Monitor.
      b. Substitutions: Or equal.

B. Type:
   1. Microprocessor based electronic transmitter/converter flow-through sample cell.
   2. Colorimetric orthophosphate analyzer for monitoring of orthophosphate according to EN ISO 687 /APHA 4500-PE.

C. Function/Performance:
   1. Accuracy: 0.01 ppm for measurement between 0.01 to 0.99 ppm, 0.1 ppm for measurement between 1.0 to 4.9 ppm, 1.0 ppm for measurement between 5 to 10 ppm.
   2. Lower Detection Limit: 0.01 mg/L.
   3. Range: 0.01-10 mg/L.
   4. Output: 4-20mA.
   5. Response: Within 10 minutes.
   6. Physical: Analyzers shall be suitable for surface mounting.
   7. Power Requirements: 120 VAC/60 Hz.
   8. Electronics enclosure shall be IP66/NEMA 4X.

9. Include flow cell made of acrylic glass with water inlet filter and flow adjustment valve.
10. Accessories Required:
    a. Provide one year's supply of manufacturer recommended consumables including, but not limited to, reagents and annual maintenance kits.
    b. Provide pressure regulator to meet sample pressure 2-28 PSI

D. Manufacturer Start-Up and Training Services:
1. Provide manufacturer's start-up and training services as specified in the start-up and training services article.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls for suitable conditions where the analyzer will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Phosphate analyzers will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. The start-up services include calibration, oversight of installations of the sensor, and start-up of the sensor/transmitter in order to provide reliable measurement at the instrument. The factory-authorized service representative or manufacturer shall work

with the PCSS and AESS to verify the transmitter sends correct information to the control system (i.e., that the scaling and units are the same at the instrument and on the control system's operator interface/PLC). Submit an instrument calibration report in order to document the calibration procedure of the instruments.

3.6 MAINTENANCE SERVICE

A. Not Required

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

B. While starting up the instruments, the manufacturer shall provide training to the Owner's instrumentation technicians. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter. Training shall be provided in accordance with Section 406126.

END OF SECTION 407569

SECTION 407813 - INDICATORS AND METERS

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

1. Section includes meters for level instruments.

B. Related Requirements:
1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.
2. Section 407213 Ultrasonic Level Meters (Continuous and Point Type).
3. Section 407346 Load Cells.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. One Panel Mounted Digital Indicator
   2. One Wall Mounted Digital Indicator

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 PANEL-MOUNTED DIGITAL INDICATORS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Red Lion Controls PAXDP Series.
      b. Substitutions: Or equal

B. Type:
   1. Digital indicator.

C. Function/Performance:

1. Accuracy: plus or minus 0.25 percent of calibrated range.
2. Operating Temperature: -20 to 70 degrees C.
3. Input: 4 to 20 mA.
4. Output: retransmitted 4 to 20 mA.
5. Digital Outputs: Two Form C programmable contacts rated for 5A at 120/240 VAC.
6. Display: No fewer than 5-digit LED display.
7. Indicator Failure: Failure of the indicator will not cause failure of the 4-20 mA loop.

D. Physical:
1. Suitable for panel mounting.
2. NEMA 4X.
3. Programmable via integrated keypad.
4. Power Requirements: 120 VAC/60 Hz.

E. Accessories Required:
1. Provide a sunshield for any indicator installed outside or in direct sunlight.

2.2 WALL-MOUNTED DIGITAL INDICATORS

A. Manufacturers:
1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
a. Precision Digital Helico Series.
b. Substitutions: Or equal

B. Type:
1. Digital indicator.

C. Function/Performance:
1. Accuracy: plus or minus 0.25 percent of calibrated range.
2. Operating Temperature: -40 to 65 degrees C.
3. Input: 4 to 20 mA.
4. Output: retransmitted 4 to 20 mA.
5. Digital Outputs: None.
6. Display: No fewer than 5-digit LED display.
7. Indicator Failure: Failure of the indicator will not cause failure of the 4-20 mA loop.

D. Physical:
1. Suitable for wall mounting.
2. NEMA 4X.
3. Programmable via integrated keypad.
4. Power Requirements: 120 VAC/60 Hz.

E. Accessories Required:
1. None.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine for suitable conditions where indicators will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 CONNECTIONS

3.4 IDENTIFICATION

A. Refer to drawings for tagging designations

3.5 FIELD QUALITY CONTROL

A. Indicators and meters will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407813

SECTION 407816 - INDICATING LIGHTS

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

1. Section includes indicating lights.

A. Related Requirements:
   1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Indicating Lights: For each color and/or type of light provided, include 20% additional, but no fewer than 2, lights as spares.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 PILOT TYPE INDICATING LIGHTS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Cutler-Hammer.
      b. Allen Bradley.
      c. General Electric.
      d. Square D.
      e. Crouse Hinds (NEMA 7).
      f. Substitutions: Or equal

B. Type: Energy efficient solid-state push-to-test LED lamps.

C. Functional:
1. Units shall be provided with low voltage LED lamps suitable for the voltage supplied.
2. Lights supplied with 120V AC power shall have integral reduced voltage transformers.
3. Lamps shall be replaceable from the front of the unit.
4. Lamps shall be push-to-test type.

D. Physical:
1. Lens color:
a. Running, on, open – Green.
b. Stopped, off, closed - Red.
c. Alarm - Amber.
d. White - Power on.
e. Blue - All other status indications not covered by the above.
f. Lens caps shall be approximately 46-inch diameter. Provide legend faceplates engraved to indicate the required function of each device; NEMA rating - 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Indicating lights will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions.
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407816

SECTION 407819 - SWITCHES AND PUSH BUTTONS

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 switches and push buttons.

B. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Selector Switches and pushbuttons: Full-size units equal to 20 percent of quantity installed, but no fewer than 4 units.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 SELECTOR SWITCHES AND PUSHBUTTONS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Allen Bradley.
      b. Crouse Hinds (NEMA 7).
      c. Cutler-Hammer.
      d. General Electric.
      e. Square D.
      f. Substitutions: Or equal

B. Type:
   1. Control devices shall be heavy-duty oil tight type with stackable contact blocks.

C. Functional:
   1. Provide contact arrangement and switching action as required for the control system specified.

D. Physical:
   1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide silver sliding contacts rated 5 amps at 125 VDC, for electronic (millivolt/ milliamp) switching provide contacts rated lamp at 28 VDC.
   2. Pushbuttons shall have flush type operators.
   3. Selector switches shall have knob or wing lever operators; NEMA rating - 4X; Provide legend plates denoting switch/pushbutton position/ function.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Switches and push buttons will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions.
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407819

SECTION 407833 - ANNUNCIATORS

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 annunciators.

B. Related Requirements:
   1. Section 406100 Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 EMERGENCY ALARM BEACON AND AUDIBLE HORN

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Benjamin.
      b. Federal Signal.
      c. Edwards.
      d. Wheelock.
      e. Substitutions: Or equal.

B. Beacon alarm light:
   1. Type:
      a. Beacon alarm light.
   2. Physical:
      a. Beacon alarm light for building exterior mounting shall be 120 VAC, flush mounted, weatherproof construction.
      b. A 750,000-candle power xenon strobe tube and red polycarbonate lens.

C. Alarm Horn:
   1. Type:
      a. Alarm horn (if applicable) shall be vibrating type for 120 Volts, 60 Hz.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and for suitable conditions where annunciators will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 FIELD QUALITY CONTROL

A. Annunciators will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions.
   2. Section 406121 – Process Control System Testing.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407833

SECTION 407853 - RELAYS

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 relays.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Relay: Full-size units equal to 25 percent of quantity installed for each size indicated.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE RELAYS AND TIME DELAYS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allen Bradley.
      b. IDEC
      c. Omron

d. Schneider Electric.
e. Substitutions: Or equal.

B. Type:
1. General purpose plug-in type.

C. Functional:
1. Contact arrangement/function shall be as required to meet the specified control function; Mechanical life expectancy shall be in excess of 10 million.
2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.
3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
4. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

D. Physical:
1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.
2. All relays shall be provided with number of poles required to meet the design intent.

E. Options/Accessories Required:
1. Provide blade terminal din rail mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.
2. Provide mounting rails/holders as required.

2.2 SIGNAL RELAY SWITCHES (CURRENT TRIPS)

A. Manufacturers:
1. Manufacturers and their products are subject to compliance with requirements. Available products that may be incorporated into the Work include, but are not limited to, the following:
a. Acromag.
b. Action Instruments Slim Pak.
c. Substitutions: Or equal.

B. Type:
1. Solid state, ASIC technology, electronic type.

C. Functional:
1. Input: 4-20 mA.
2. Output: Isolated contact output, double pole double throw, rated 5 amps at 120 VAC.
3. Accuracy: 0.1 percent.
4. Protection: Provide RFI protection.
5. Deadband: Adjustable between 0.1 and 5.0 percent of span.
6. Set point Adjustment: Single Point alarms shall be adjustable to trip on rising or falling input signal, dual point alarms shall be adjustable to trip on rising and falling input signals.
7. Repeatability: Trip point repeatability shall be at least 0.1 percent of span.

D. Physical:
   1. Mounting: DIN rail.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.2 IDENTIFICATION

A. Refer to drawings for tagging designations

3.3 FIELD QUALITY CONTROL

A. Relays will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121– Process Control System Testing.

3.4 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407853

SECTION 407856 - ISOLATORS, INTRINSICALLY SAFE BARRIERS, AND SURGE SUPPRESSORS

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 isolators, intrinsically safe barriers, and surge suppressors.

B. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 TECHNOLOGY OBSOLESCENCE MITIGATION

A. Not applicable to this Section.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.11 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.12 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 SURGE PROTECTION FOR CONTROL SYSTEMS

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Citel DLA series
      b. MJ8 series,
      c. MTL Surge Technologies (Telematic) NP Series,
      d. Phoenix Contact PlugTrab Series,
      e. Transtector FSP Series,
      f. Substitutions: Or equal.

B. General - Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the plant electrical system. The protection systems shall be such that the protective level shall

not interfere with normal operation but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring. Devices shall have a response time of less than 50 nanoseconds and be capable of handling a discharge surge current (at an 8x20µs impulse waveform) of at least 8 kA.

C. Provide protection of all analog signal (4-20 mA) circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Protection devices located near the transmitter shall be mounted in a separate NEMA 4X enclosure or conduit mounted, and shall be Phoenix Contact PT Series, MTL Surge Technologies (Telematic) TP48, Citel TSP-15M series, or equal. Substitution of a single device to protect both 120 VAC and 4-20 mA wires to an instrument is acceptable. Protection devices in control panels shall be MTL Surge Technologies (Telematic) SD Series, Phoenix Contact PT Series, Citel DLA series, Citel CAD series or equal.

D. Provide protection of all 120 VAC power feeds into control panels, instruments, and control room equipment. Surge protective devices shall be Transtector ACP-100BW Series, Phoenix Contact "Mains-PlugTrab", MCG Surge Protection 400 Series, Citel DS40 series, or equal.

E. Non-Fiber Based Data Highway or Communications Circuits: Provide protection on all communication and data highway circuits that leave a building or are routed external to a building. Provide circuit protection at both ends of the line.
   1. Products: Provide one of the following surge protective devices:
      a. Phoenix Contact PlugTrab Series,
      b. Transtector FSP Series,
      c. MTL Surge Technologies (Telematic) NP Series,
      d. Citel DLA series
      e. MJ8 series,
      f. Or equal.

F. Inductive Loads: Provide coil surge suppression devices, such as varistors or interposing relays, on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls, floors, roofs, and rooms for suitable conditions where the surge suppressors will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations.

3.4 FIELD QUALITY CONTROL

A. Surge suppressors will be considered defective if they do not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 SOFTWARE SERVICE AGREEMENT

A. Not Required

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407856

SECTION 407859 - POWER SUPPLIES

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. Related Requirements:
   1. Section 406100 – Process Control and Enterprise Management Systems General Provisions for submittal requirements.

1.3 PREINSTALLATION MEETINGS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions for preinstallation meetings

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

B. LEED Submittals:
   1. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

C. Shop Drawings:
   1. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.5 INFORMATIONAL SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.6 CLOSEOUT SUBMITTALS

A. Refer to Section 406100 – Process Control and Enterprise Management System General Provisions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. None Required

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

1.10 FIELD CONDITIONS

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions.

1.11 WARRANTY

A. Refer to Section 406100 – Process Control and Enterprise Management Systems General Provisions

PART 2 - PRODUCTS

2.1 24 VDC POWER SUPPLIES

A. Manufacturers:
   1. Manufacturers and their products are subject to compliance with requirements. Provide one of the following:
      a. Allen-Bradley.
      b. Phoenix Contact.
      c. SOLA HD.
      d. Substitutions: Or equal.

B. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.

C. Provide redundant power supplies that operate in parallel with an independent redundancy module to power field instruments and panel devices as shown on the drawings.

D. The 24 VDC power supply shall meet the following requirements:
   1. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.
   2. Output voltage: 24 VDC.
   3. Output voltage adjustment: 5 percent.

4. Line regulation: 0.05 percent for 10 volt line change.
5. Load regulation: 0.15 percent no load to full load.
6. Ripple: 3 mV RMS.
7. Operating temperature: 32 to 140 degrees Fahrenheit.

E. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity.

F. If power supply on/off status signal is shown on drawings, provide a relay contact (internal to the power supply redundancy module or external if the power supply is not so equipped) to indicate on/off status of the power supply.

G. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

H. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine panel for suitable conditions where power supplies will be installed.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

3.3 IDENTIFICATION

A. Refer to drawings for tagging designations

3.4 FIELD QUALITY CONTROL

A. Power supplies will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports in accordance with the following:
   1. Section 406100 – Process Control and Enterprise Management General Provisions
   2. Section 406121 – Process Control System Testing.

3.5 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 407859

SECTION 434113 - WELDED STEEL TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Welded steel tanks.
   2. Tank coating and lining.

B. Related Requirements:
   1. Section 003100 - Available Project Information: Subsurface investigation report, bore hole locations, and findings of subsurface materials.
   2. Section 099100 - Painting

1.2 DEFINITIONS

A. Sodium hydroxide is also known as sodium hydroxide, the chemical to be stored by welded steel tanks.

1.3 REFERENCE STANDARDS

A. American Concrete Institute:
   1. ACI 318 - Building Code Requirements for Structural Concrete.

B. American Water Works Association:
   1. AWWA D100 - Welded Carbon Steel Tanks for Water Storage.

C. American Welding Society:
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   2. AWS QC1 - Standard for AWS Certification of Welding Inspectors.

D. ASME International:
   1. ASME Boiler and Pressure Vessel Code - Section IX - Qualification Standard for welding and Brazing Procedures, Welders, Brazers, and Welding Brazing Operators.

E. ASTM International:
   1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

F. Code of Federal Regulations:
   1. 29 CFR Part 1926.502.

1.4 COORDINATION

A. Section 013000 - Administrative Requirements: Requirements for coordination.

B. Coordinate Work of this Section with location and placement of utilities and piping.

1.5 PREINSTALLATION MEETINGS

A. Section 013000 - Administrative Requirements: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.6 SCHEDULING

A. Section 013000 – Project Management and Coordination

B. Schedule Work of this Section after concrete work for support pad and prior to connecting utility and piping Work.

1.7 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data:
1. Submit data for expansion joint fittings and other pipe specialty fittings.
2. Submit data for ladder and ladder safety devices.
3. Submit information concerning materials of construction, fabrication, and protective coatings.

C. Shop Drawings:
1. Indicate complete plan, elevation, and sectional drawings showing critical dimensions.
2. Indicate structural plate and support member sizes and thickness.
3. Indicate weld types and sizes.
4. Indicate chemical supply and overflow piping details, including fittings, expansion joints, pipe support methods.
5. Indicate ladder and ladder safety device details.
6. Indicate handrail details.
7. Indicate access hatch details.
8. Description of surface preparation and shop priming, including manufacturer and dry film thickness applied.

D. Manufacturer's Certificate:
1. Certify that products meet or exceed specified requirements.
2. Submit certified list of tank installations storing same liquid and concentration, in service for period of not less than five years.
3. Provide a certified letter from tank manufacturer that the method of fabrication is compatible with the intended use of the tank, which is for the following service:
    a. Sodium hydroxide (25%)
    b. Suitable for vertical installation in an enclosed thermally controlled environment.

E. Owner Installation Certificate: Obtain from tank manufacturer's representative and submit, attesting that tank has been properly installed and is ready for startup and testing.

F. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS within previous 12 months.

G. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for tank structural components.

H. Test and Evaluation Reports:
1. Submit mill test reports.
2. Submit certified factory and field test results.
3. Written Report Certifying Work: Prepare and submit as indicated in AWWA D100.
4. Submit radiographic film and test segments, identified to shell plate diagrams, at completion of Work.
5. Submit installation certificate from equipment manufacturer's representative, as described in

I. Manufacturer Instructions: Submit detailed instructions on installation requirements, including tank handling procedures, anchoring, and layout.

J. Source Quality-Control Submittals: Indicate results of factory tests and inspections.

K. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

L. Manufacturer Reports:
1. Submit certification after installation that tank has been installed according to manufacturer instructions.
2. Submit details of welded joints, as indicated in AWWA D100.

M. Qualifications Statements:
1. Submit qualifications for manufacturer, fabricator, erector, and licensed professional.
2. Submit manufacturer's approval of erector.
3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.
4. Submit qualifications of certified welding inspector.

1.8 CLOSEOUT SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations and final orientation of tank and accessories.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Section 017000 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials: Furnish two safety harnesses for ladder safety rail system.

1.10 QUALITY ASSURANCE

A. Perform Work according to AWWA D100.

B. Perform Work according to City of Flint Department of Public Works standards.

C. Maintain copy of each standard affecting Work of this Section on Site.

D. The Contractor shall assume responsibility for the satisfactory installation and operation of each of the tanks, including the interior lining and exterior coating systems and accessories.

E. Equipment Factory Testing.
   1. General
      a. Conduct tests on actual equipment to be furnished to the job site.
   2. Steel Tanks
      a. Tanks shall be tested at the factory for leaks in accordance with the ASME Code Section VIII, Division 1. The tank shall be tested either hydrostatically standing up with the tank filled with water to the top or pneumatically at a pressure equivalent to the hydrostatic pressure of the vessel contents assuming the vessel is completely filled. Tanks shall be checked for leaks after they have been filled for at least 24 hour. The Engineer may request that this test be performed in his/her presence at the time of tank inspection. Otherwise, manufacturer shall run this test prior to the time of inspection. Any leaks shall be repaired and the tests repeated at no additional cost to the Owner. Obtain approval of shop testing from Engineer prior to shipment. Inspection records for hydrostatic/pneumatic testing shall be made for each tank. Records shall be sent to the Engineer for review and approval prior to tank shipment.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

B. Fabricator: Company specializing in fabricating products specified in this Section with minimum three years' documented experience.

C. Erector: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

D. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in State of Michigan.

E. Welders: AWS qualified within previous 12 months for employed weld types.

F. Certified Welding Inspector: Comply with AWS QC1.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Insofar as is practical, the equipment specified herein, shall be factory assembled. The parts and assemblies that are shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field.

C. Flange faces shall be protected from damage. All openings are to be covered with securely bolted wooden blank flanges to prevent the entrance of dirt, water, and debris.

D. Tanks shall be mounted on skids or protective framework so constructed as to provide for easy handling for fork truck or similar device and/or be provided with lifting lugs or cleats to permit handling by crane. Nozzles, manholes, or other fittings shall not be used for lifting.

E. Weight, handling instructions for unloading and installation, type of storage required, and instructions for protective maintenance during storage shall be included with each shipment to the project site.

F. Tanks shipped horizontally shall be supported by cradles supporting 120 degrees of the tank circumference.

G. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

H. The steel tank will be installed by the Contractor as shown on the approved Shop Drawings and as recommended by the manufacturer’s representative. The Contractor shall also make the required pipe connections.

I. Store materials according to manufacturer instructions.

J. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.13 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.14 WARRANTY

A. Section 017000 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five -year manufacturer's warranty for welded steel tanks.

C. Any areas exhibiting delaminations, blistering, holidays, or other like anomalies shall be removed and replaced at no additional cost to the Owner. Rework shall be scheduled and completed in a period not to exceed seven (7) days from the date of notification by the Owner.

PART 2 - PRODUCTS

2.1 TANKS

A. Manufacturers
1. M and M Welding
2. West Warwick Welding
3. Steel Structures Inc.
4. Springs Fabrication Inc.
5. R.L. Morton Welding Inc.
6. Substitutions: As specified in Section 016000 - Product Requirements.

B. Description:
1. Design, fabricate, and erect 6,000-gal. and 210-gal. ground-level, welded steel tanks and accessories.

C. Performance and Design Criteria:
1. Stored Liquid: Sodium Hydroxide (25%)
a. pH 14
b. Ambient Temperature Range: 55º to 100ºFSpecific Gravity at 77ºF: 1.53

2. Roof:
a. As indicated on Drawings.
b. Support: Self-supporting and flat.

3. Corrosion Allowance: Not required.
4. Type: Vertical, cylindrical, flat bottom, flat top
5. NSF 61 Certified for treatment of potable water
6. Location of Site: As indicated on Drawings.

2.2 PIPING

A. Inlet, Outlet, and Overflow:
1. Material: Steel.
2. Comply with ASTM A53/A53M.
3. Grade B, Schedule 80.
4. Joints: Seamless, welded and flanged

2.3 FABRICATION

A. Construction Sequence and Methods
1. The tank shall be constructed utilizing single plate ring design with full penetration continuous butt welding inside and out and shall be in accordance with the latest edition of the ASME Code for Unfired Pressure Vessels (but not code stamped) and the Structural Welding Code.
2. The vessel shall be completely shop welded with no field welding permitted.

3. The tank shall be fabricated from a minimum number of pieces. All longitudinal shell seams shall be staggered. Welding on the tank shall be located to clear all nozzle openings.
4. All welding on the tank shall be completed prior to the application of the exterior coatings.
5. All welded and machined edges shall be ground smooth to a minimum 1/8-inch radius, as required for compatibility with the coating.
6. Piping connections shall be welded to the tanks.

B. Welding
1. The technique of welding employed, appearance, and quality of the weld made, and the method of correcting defective work shall conform to the ASME Specifications.
2. Surfaces to be welded shall be free from coarse scale, rust, grease, paint, and other foreign materials, except that mill scale which will withstand vigorous wire brushing may remain. A light film of linseed oil may also be disregarded.
3. No welding shall be done when the temperature of the base metal is lower than 10ºF.
4. Tank components shall be carefully fitted to form joints that are free of voids. Voids filled with weld metal will not be accepted.

C. Balcony: Not required.

D. Pipe and Pipe Connections:
1. Provide other accessories as indicated on Drawings.
2. Overflow:
   a. As indicated on Drawings.
   b. Diameter: As indicated on Drawings.
   c. Furnish welded-joint steel overflow pipe as indicated on Drawings, suitably supported and extending to grade level.
   d. Furnish overflow pipe to handle flow rate of 250 gpm at high water level.
   e. Terminate overflow pipe at 1 foot above finished grade to provide air break.
   f. Provide s stainless steel mesh insect screen per the Drawings

E. Roof Ladder: As indicated on Drawings.

F. Safety Rail.

G. Comply with 29 CFR Part 1926.502.

H. Furnish along entire ladder length and extend 42 inches above tank roof.

I. Surface Preparation: As specified in Section 099100 - Painting.
1. Shop and finish painting of exterior: Factory paint, manufacturer's standard polyurethane enamel (2 coats, minimum 3 mils minimum dry film thickness) with epoxy primer (1 coat, minimum 2.5 mils minimum dry film thickness). Abrasive blast surface to SP 10 condition prior to coating. Color shall be approved by Owner.
2. The tank interior surfaces shall be:
   a. Shall be lined with a baked-on coating system as specified herein and applied at the shop. The lining shall extend into all flange nozzles and manway connections, including the flange gasket surface. The baked-on coating shall be applied in accordance with the coating manufacturer's recommendations.

b. Interior coating for sodium hydroxide shall be suitable for the service conditions herein. The coating manufacturer shall submit a letter during the submittal process approving the coating material and procedures to be used for the coating system.
c. Provide manufacturer's coating and application specification to the Engineer for approval prior to tank fabrication.

3. The interior baked-on phenolic coating shall be applied as follows:
   a. Applicator: The applicator for the installation of baked-on phenolic coating shall demonstrate previous experience with application of this type of coating as specified herein.
   b. Tank Preparation: Prior to application of interior coating, surfaces shall be cleaned and blasted to a white finish according to SP-5 of the Structural Steel Painting Council (SSPC) specifications. Surface profile or anchor pattern shall be 20 to 25 percent of the recommended dry film thickness.
   c. Application of Baked-on Coating: The interior tank wall coating shall be suitable for use with the chemical to be stored (50% sodium hydroxide solution), and shall be ChemLine 784/32 by Advanded Polymer Coatings, or approved equal. Two (2) coats of ChemLine 784/32 or approved equal shall be factory applied for an average dry film thickness of 12 to 16 mills with a spot maximum thickness of 22 mils and a minimum spot thickness of 8 mils. All linings and coatings shall extend through all tank openings and nozzles and around to flange faces.
   d. Insufficient Thickness and Holiday Repair: All holidays, discontinuities, and insufficient film thickness shall be repaired in accordance with the coating manufacturer's established repair instructions regarding surface preparation, coating application, and rebake. Retesting of repaired

J. Seal Welding: Provide seal welds for butt welds and lap joints in wet areas, including interior roof surfaces.

K. Materials.
1. Shell and Plate: ASTM A285, Grade C, 3/8-inch thickness (minimum).
2. Nozzles: ASTM A53, Grade B, Seamless, Schedule 80.
3. Flanges: ADTM A181, Class 70, ASTM A285, Grade C, flange quality.
4. Structural Shapes: ASTM A36, minimum thickness ¼-inch.
5. Internal Piping:
   a. Carbon steel pipe conforming to the requirements of Section 400524. Pipe to be internally and externally lines with the same liner specified for the tank. Internal piping shall be constructed with welded fittings.
6. Bolts and Nuts.
   a. External: Type 316 stainless steel hex head bolts, hexagonal nuts and washers.
   b. Internal: Type 316 stainless steel hex head bolts, hexagonal nuts and washers.
7. Gaskets: EPDM, full face, minimum 1/8-inch thick.

L. Concrete: Comply with ACI 318.

M. Specification Sheet for Seismic Data: Not required.

N. Additional Accessories:
1. Lifting lugs.
2. Nozzles: Flanged nozzles shall be provided for the tanks as indicated herein and shall be the manufacturer's standard design and shall be coordinated with the Contractor. Flange diameters and drillings shall meet ANSI B16.5 Class 150 standard. All nozzles shall

extend 5 inches outside the surface of the tank unless noted otherwise. The feed outlet line shall terminate 3 inches above the tank bottom inside of the tank. The filling line(s) shall be flanged on the inside and outside of the tank. A flanged pipe shall extend into the tank to a point 1 foot above the bottom. Four 3/8-inch diameter holes shall be drilled into the filling line just below the top of the tank flange to provide adequate venting for siphon prevention.

3. Support Saddles: The tank shall be fabricated with integral welded steel support saddles, for supporting and anchoring the tank to the concrete support pad(s).
4. Piping Support Lugs: Provide integrally constructed supports for pipe attached to tank nozzles. Coordinate required locations with the tank manufacturer.
5. Brackets and supports shall be shop-welded onto the tanks. No welding to tanks shall be allowed after linings have been installed. Ladders, handrails, safety cages and related devices and systems shall be bolted onto the brackets and supports. All such ladders, handrails, and safety cages shall be shipped to site disconnected from the tanks.
6. Provide external ladders for use with storage tanks. The ladder included bolts, nuts, reinforcements, braces, anchors, and all other supporting equipment shall be hot dip galvanized. The ladder shall be painted to match the tank. Ladders shall meet OHSA Standards.

2.4 SOURCE QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for testing, inspection, and analysis.

B. Provide shop inspection and testing of completed assembly.

C. Owner Inspection:
1. Make completed tank components available for inspection at manufacturer's factory prior to packaging for shipment.
2. Notify Owner at least seven days before inspection is allowed.

D. Owner Witnessing:
1. Allow witnessing of factory inspections and tests at manufacturer's test facility.
2. Notify Owner at least seven days before inspections and tests are scheduled.

E. Certificate of Compliance:
1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
2. Specified shop tests are not required for Work performed by approved manufacturer.

2.5 SAFETY SIGNAGE AND TANK LABELING

A. Provide NFR designation of chemical conforming to the specifications contained in the NFPA 704, Recommendations for Identification of Fire Hazards of Materials. Hazardous materials classification shall include rating for health, flammability, reactivity, and specific hazard. Sign shall measure 18-inch by 18-inch. The sign shall be mounted on equipment at a height and location clearly visible for all personnel.

B. Safety sign shall be shop fastened to be readily visible when tanks are installed.

C. All tanks shall be stenciled with their name, tag number (as shown on the P&IDs), and with the "UN" chemical number as assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods. For example, Caustic Soda Bulk Storage Tank shall read:

CAUSTIC SODA BULK STORAGE TANK
T-2100
UN1824

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 017000 – Execution and Closeout Requirements: Requirements for installation examination.

B. Verify layout and orientation of tank accessories, utilities, and piping connections.

3.2 PREPARATION

A. Section 017000 - Execution and Closeout Requirements: Requirements for installation preparation.

B. Thoroughly clean storage tank pad, removing loose concrete, dust, and other debris.

C. Place building paper on pad according to tank manufacturer instructions prior to erecting tank.

3.3 INSTALLATION

A. According to AWWA D100, as indicated on Drawings, and according to manufacturer instructions.

B. Connect piping to tank.

C. Following the field test and repair of leaks, the tanks shall be anchored in their final position according to the manufacturer's recommendations.

D. Install tank accessories not factory mounted to complete installation.

E. All interior surfaces of the vessel shall be cleaned and decontaminated. This includes all loose or removable accessories.

F. Each surface to be cleaned shall be cleaned with mild detergent capable of removing grease, or other residue. No abrasive cleaning agents shall be used. This detergent shall then be thoroughly rinsed off with fresh water through a spray mechanism. Care shall be taken in order to not damage the surface being cleaned.

G. After testing, the tanks shall be thoroughly cleaned with a mild detergent and dried before use.

H. All marred and damaged coatings shall be repaired by the Contractor so as to maintain the coating integrity in accordance with the manufacturer's requirements.

I. Field Painting: As specified in Section 099100 - Painting

3.4 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Requirements for inspecting and testing.

B. Inspection and Testing:
   1. Inspection and Testing of Welds:
      a. Examine weld joints according to AWWA D100.
      b. Comply with procedure requirements of AWWA D100 prior to proceeding with radiographic Work.
      c. Immediately notify Architect/Engineer of weld locations failing to meet standards of AWWA D100.
      d. Repair and re-inspect defective welds until acceptable.
   2. Hydrostatic Testing:
      a. Test completed and cleaned tank for liquid tightness by filling tank to its overflow elevation with water provided by Owner.
      b. Conduct test minimum 48 hours.
      c. Correct leaks disclosed by this test.
      d. Drain and legally dispose test water off Site.
   3. Field Welds:
      a. Testing and Inspection: Comply with AWWA D100.
      b. Furnish certified welding inspector responsible for all weld inspections, as indicated in AWWA D100.

C. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

D. Manufacturer Services: Furnish field representative experienced in installation of tank to supervise installation.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 FIELD PAINTING

A. All marred and damaged coatings shall be repaired by the Contractor so as to maintain the coating integrity in accordance with the manufacturer's requirements.

3.6 ATTACHMENTS

A. Welded Steel Tank Schedule: (Refer to the Tank Details on the Drawings)

   1. T-2100: Caustic Soda Bulk Storage Tank

      a. Material Stored: Sodium Hydroxide (25%).

b. Dimensions: 9-ft diameter by 13-ft sidewall.
c. Capacity: 6000 gallons.

2. T-2500: Caustic Soda Day Tank

a. Material Stored: Sodium Hydroxide (25%) Day Tank.
b. Dimensions: 3-ft diameter by 5-ft sidewall.
c. Capacity: 210 gallons.

END OF SECTION 434113

SECTION 434143 - HIGH DENSITY POLYETHYLENE TANKS

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. Rotationally molded, vertical, high density polyethylene tanks.
   2. Tank accessories.
   3. Tank anchoring hardware.

B. Chemicals stored: sodium hypochlorite (10-15%) and corrosion inhibitor (70% orthophosphate and 30% polyphosphate).

C. Related Requirements:
   1. Section 033000 “Cast in Place Concrete” Support pads**.**
   2. Division 40 “Process Interconnections” for associated pipes, tubes, fittings, and valves.

1.3 DEFINITIONS

A. ARM: Association of Rotational Molders

B. ASTM: American Society for Testing and Materials

C. HDPE: High Density Polyethylene.

D. XLHDPE: Crosslinked High-Density Polyethylene.

E. LPE: Linear (Low Density) Polyethylene

F. UV: Ultra-violet.

1.4 COORDINATION

A. See Section 013000 “Administrative Requirements” for coordination requirements.

B. Coordinate Work of this Section with the Drawings.

1.5 PREINSTALLATION MEETINGS

A. See Section 013000 “Administrative Requirements” for preinstallation meeting requirements.

B. Convene minimum one week prior to commencing installation work of this Section.

1.6 SCHEDULING

A. Section 013100 “Project Management and Coordination” for scheduling requirements.

B. Schedule Work of this Section after concrete Work for support pad and prior to connecting utility and piping Work.

1.7 ACTION SUBMITTALS

A. See Section 013300 “Submittal Procedures” for submittals requirements.

B. Product Data: Include rated capacities, accessories, appurtenances, and furnished specialties for each storage tank indicated.

1. Ladder and ladder safety devices.
2. Information concerning materials of construction and fabrication.
3. Personnel access manways and covers and associated hardware dimensions, materials and assembly details.
4. Nozzle and nozzle hardware dimensions, materials and assembly details.
5. Resin used and certification of chemical resistance. A letter stating that the resin used in the fabrication of the tank is fully compatible with the service and chemicals specified in this specification. The letter shall state that the fabricator has reviewed the SDS sheets of all the chemical contents that will be stored in the tanks including the summary of hazards, and physical and chemical data. Contractor shall request SDS sheets of all chemicals from the Engineer.
6. Anchoring systems.
7. Tank base padding material.
8. A certificate of ANSI/NSF standard 61 certification.

C. Shop Drawings: Show fabrication and installation details for each storage tank, including the following:

1. Complete plan, elevation, and sectional drawings showing critical dimensions.
2. Tank wall and floor thickness.
3. Tank weight.
4. Locations, elevations, dimensions and sizes of manways, access openings, nozzles, nozzle flats, anchoring points.
5. Access openings (manways), covers, pipe connections, and accessories.
6. Ladder and ladder safety device details.
7. Roof handrail details.
8. Tank labeling text, size, layout and locations.
9. Heating and insulating details including wiring diagrams and power requirements (if specified).

10. Anchoring system details including anchor bolt embedment length.
11. Manufacturer supplied tank pad dimensions and details.

D. Samples:
1. 6” x 6” segment of manway cutout.

1.8 DELEGATED DESIGN SUBMITTALS

A. Wall thicknesses calculations per ASTM D1998.

B. Anchorage and/or hold down device calculations stamped by a professional civil or structural engineer registered in the State of Michigan demonstrating that each tank will adequately transfer seismic, wind or hydraulic forces from the vessels to the anchor bolts at the foundation. Submit with the calculations a tabulation of all loads imparted on the foundation by the tank.

1.9 INFORMATIONAL SUBMITTALS

A. Manufacturer's Certificate:
1. Ten years prior experience in construction of rotationally molded XLHDPE tanks.
2. Certification of material compatibility for chemical stored including tank, nozzles, hardware and elastomers.

B. Manufacturers' Instructions: Detailed instructions on installation requirements, including tank transport handling, storage and anchoring procedures and anchoring layout.

C. Source Quality-Control Submittals: Results of shop tests and inspections:
1. Impact Test per ASTM D1998, Section 11.3 at – 20 degrees F. Sample passes if it does not shatter or crack at:
   a. 120 ft/lbs for a 1/2-inch wall thickness
   b. 100 ft/lbs for a wall thickness less than 1/2-inch.
2. Degree of Crosslinking Test per ASTM D1998, Section 11.4. Sample passes if gel percent is 60 to 70 percent
3. Hydrostatic Test. Fill the tank with water to the top of the side wall. Tank passes if there are no leaks after one hour and no significant bulging or shape deformation.
4. Wall thickness. Measure actual wall thickness measurement at one-foot elevation intervals up to three feet from the bottom of the tank.
5. Prepare and submit complete inspection reports for each tank. Provide, on Owner’s request, a copy of inspection records for review prior to shop inspection by the Owner.

D. Field Quality-Control Submittals:
1. Results of Contractor furnished tests and inspections.
2. Owner Installation Certificate: Signed and dated certificate from manufacturer's representative that tank has been properly installed and is ready for filling.

1.10 CLOSEOUT SUBMITTALS

A. See Section 017700 “Closeout Procedures” for submittals requirements.

B. Field Quality-Control Submittals: Results of Contractor-furnished tests and inspections.

C. Manufacturer Reports: Certify that tank has been installed according to manufacturer instructions.

D. Project Record Documents: Record actual locations of tank and accessories.

E. Operation and Maintenance Data: For tanks, accessories, and appurtenances to include in emergency, operation, and maintenance manuals.

1.11 QUALITY ASSURANCE

A. Fabricate like items of the same materials at one shop to standardize quality and appearance in accordance with ASTM D1998.

B. Perform Work according to City of Flint Department of Publics Works standards.

C. Maintain a copy of each standard affecting Work of this Section on Site.

1.12 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten years' documented experience.

B. Licensed Professional: Professional engineer with at least five years of experience in design of specified Work and licensed in State of Michigan.

1.13 DELIVERY, STORAGE, AND HANDLING

A. See Section 016000 “Product Requirements” for transporting, handling, storing, and protecting products requirements.

B. Deliver materials in manufacturer's packaging including application instructions. Do not ship tanks with ladders, handrails or external piping assembled.

C. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

D. Store materials according to manufacturer's instructions.

E. Protection:
   1. The Manufacturer is responsible for packaging to prevent damage to the tanks during transit and handling.
   2. Provide additional protection according to manufacturer instructions.

3. Protect flange faces and other openings with a minimum 1/2-in thick wooden blind flange secured in place with temporary nuts and bolts in each bolt hole to prevent entrance of dirt, water and debris.
4. Protect threaded and socket nozzles with plugs securely taped in place.
5. Provide instructions for unloading and installation of the tanks, using lifting and tailing lugs as needed for handling by for crane, fork truck or similar device. Do not use nozzles, manways, or other fittings for lifting.
6. Wrap ladders, railings, sight gages and other components removed for shipment to prevent damage during shipment.
7. Do not ship loose components inside the tanks.

1.14 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.15 WARRANTY

A. Section 017700 “Closeout Procedures” specifies requirements for warranties.

B. Furnish five year manufacturer's warranty that equipment is free of defects in design, fabrication, material and workmanship.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

1. Refer to the Drawings.

2.2 HDPE TANKS

A. Manufacturers
   1. PolyProcessing Inc.
   2. Assmann Corporation of America

B. Description: Rotationally molded, XLHDPE construction;
   1. Cylindrical, flat-bottomed and vertical
   2. Dimensions, details and accessories as described in the Tank Dimensions.
   3. Hoop Stress Value:
      a. No greater than 600 psi at 100 °F.
      b. Decrease to 300 psi at 150 °F.
      c. Safety Factor: No less than 2 using Barlow formula for calculating wall thickness.
   4. Knuckle Radius: Bottom to wall - Minimum 1-inch.
   5. Design specific gravity: 1.5 or greater

6. Finish: Smooth surfaces free from visual defects, such as foreign inclusions, air bubbles, pin holes and craters.
7. Tolerance Outside Diameter Including Out-of-Roundness: Plus/minus 1 percent.
8. Trim cut outs to have smooth edges.
9. All of the gaskets shall be compatible with the contents of the tank.
10. Chemicals will be stored inside with temperatures normally ranging from 55° to 85°F.

C. Tank Dimensions
   a. Sodium Hypochlorite Bulk Storage Tanks
      1) Equipment Numbers: T-1110 and 1120
      2) Quantity: 2
      3) Type: Vertical, cylindrical, flat bottom, flat top
      4) Storage Capacity: 3,000 gallons
      5) Nominal Diameter: 7-ft 1-in to 7-ft 6-in
      6) Minimum Nominal Straight Shell Length:8-ft 11-in to 10-ft 6-in
      7) Design Pressure: +/- 10-inch water column
      8) Chemical: 10-15% sodium hypochlorite
      9) Specific Gravity: 1.24
      10) pH: 12.7
      11) Connections: Refer to Tank Connection Schedule on the Drawings
      12) Ladder: Required
   b. Sodium Hypochlorite Day Tank
      1) Equipment Numbers: T-1500
      2) Quantity: 1
      3) Type: Vertical, cylindrical, flat bottom, flat top
      4) Storage Capacity: 110 to 120 gallons
      5) Nominal Diameter: 2-ft 5-in to 2-ft 6-in
      6) Minimum Nominal Straight Shell Length:3-ft 11-in to 4-ft 4-in
      7) Chemical: 10-15% sodium hypochlorite
      8) Specific Gravity: 1.24
      9) pH: 12.7
      10) Connections: Refer to Tank Connection Schedule on the Drawings
      11) Ladder: Not Required
   c. Corrosion Inhibitor Bulk Storage Tank
      1) Equipment Numbers: T-3100
      2) Quantity: 1
      3) Type: Vertical, cylindrical, flat bottom, flat top
      4) Storage Capacity: 2,000 gallons
      5) Nominal Diameter: 7-ft 1-in to 7-ft 2-in
      6) Minimum Nominal Straight Shell Length: 6-ft 6-in to 7-ft 2in
      7) Design Pressure: +/- 10-inch water column
      8) Chemical: 70% orthophosphate, 30% polyphosphate
      9) Specific Gravity: 1.41
      10) pH: 5.3
      11) Connections: Refer to Tank Connection Schedule on the Drawings
      12) Ladder: Required
   d. Corrosion Inhibitor Day Tank
      1) Equipment Numbers:

2) Equipment Number: T-3500
3) Quantity: 1
4) Type: Vertical, cylindrical, flat bottom, flat top
5) Storage Capacity: 60 gallons
6) Nominal Diameter: 1-ft 11-in
7) Overall Height: 3-ft 6-in
8) Chemical: 70% orthophosphate, 30% polyphosphate
9) Specific Gravity: 1.41
10) pH: 5.3
11) Connections: Refer to Tank Connection Schedule on the Drawings
12) Ladder: Not Required

2.3 RESIN

A. Manufacturers
1. Exxon/Mobile Chemical Paxon 7000 series
2. Chevron Phillips Marlex HMN TR-942
3. Or approved equal

B. Properties

Molded Properties	Test Based On	Typical Values XLHDPE	Typical Values HDPE	Unit
Tensile Strength at Yield	ASTM D 638	2,800	2,950	PSI
Tensile Elongation at Yield	ASTM D 638	20	10	%
Tensile Elongation at Break	ASTM D 638	700	>1000	%
Flexural Modulus 1% Secant	ASTM D 790 PROCEDURE B	87,000 to 100,000	110,000 to 129,000	PSI
Impact Strength @ -40˚C 1/8" thickness ¼" thickness	ARM	 74 190	 64 170	 ft-lbs. ft-lbs.
Notched IZOD Strength @ -40˚F	ASTM D 256	4.3	4.3	ft-lb/in
Gel Content	ASTM D2765	60 to 70%	NA	%
Vicat Softening Temperature	ASTM D1525	250	235	ºF
Environmental Stress Crack Resistance 100% Igepal 10% Igepal	ASTM D 1693 Condition A $F_0 > 1{,}000$ $F_0 > 1{,}000$	 	 $F_0 > 700$ $F_0 > 250$	 hr hr
Deflection temperature @ 66 psi @ 264 psi	ASTM D 648	 142 110	 136 99	 ºF ºF

C. Additives
1. Long term U.V. stabilizer.
2. White pigment not to exceed 0.5 percent of dry blended or 2 percent if melt compounded of the total weight of the tanks.

3. Anti-oxidant: Increase the concentration of anti-oxidant by a factor of four in non-crosslinked resin (entire tank or melt-bonded liner) for applications with sodium hypochlorite and sulfuric acid, and other oxidizing chemicals.

2.4 NOZZLES

A. Bolted flanged fittings with the bolt heads on the inside of the tank for tank overflow and top mounted nozzles.

B. Install tank top nozzles on the flat sections of the top except as shown on the Tank Figures.

C. For nozzles on non-flat sections of the tank top, use bolted flanged nozzles with universal balls to facilitate alignment.

D. For flanges greater than 3-inch diameter on the side wall, machine the flange faces to contour to the tank.

E. Flange bolting per ANSI 16.5, 150-pound design, with:
1. Gaskets between the washer on the inside of the tank and the tank.
2. A gasket between the outside flange and the tank.
3. Bolting material that is compatible with the stored chemical.

F. Cover bolt heads and washers inside the tank with polyethylene caps.

G. Pump Suction:
1. For each tank, provide either:
   a. An integrally molded flanged outlet constructed of the same material as the tank and formed with the tank molding and a split-ring backer flange, or
   b. A bushing of chemically resistant metal and molded into the tank as the tank is formed, O-rings as needed to seal the bushing, and threaded fitting to adapt the outlet to a flange.

2.5 MANWAYS AND COVERS

A. Tank Top Manways
1. 24-inch diameter with bolted cover for tanks 2000 gallons and larger.
2. 19-inch with a threaded cap and gasket for tanks smaller than 2000 gallons.
3. 12-inch with a threaded cap and gasket for tanks smaller than 300 gallons.
4. Gasketed and guaranteed fume tight.

2.6 LADDERS, RAILINGS AND PLATFORMS

A. Ladder for Tank-Top Manway Access
1. OSHA compliant design.
2. Floor supported for vertical load, braced to molded-into-the-tank fittings at the top of the tank for lateral support.

3. Ladder accessories
    a. Anchor brackets for floor mounting
    b. Stand-off brackets at the tank top
    c. Fasteners

2.7 ACCESSORIES

A. Gasket materials shall be compatible with the chemical stored.

B. Lifting lugs designed and fabricated with a 5-times load safety factor.

C. Hold-down cables and associated hardware and floor mounted anchor brackets for wind and seismic restraints.

D. Tank Labels
1. Chemical specific label, with 6-inch high lettering
    a. NFPA 704 four-diamond hazard identification label
    b. Chemical Name
    c. Tank number
2. Manufacturer's label, standard lettering height
    a. Manufacturer's name
    b. Month and year of manufacture
    c. Serial number
    d. Tank capacity in gallons (straight side)
    e. Design specific gravity
    f. Design pressure
    g. Materials of construction

E. Support Pad
    a. Concrete tank pad per the design drawings with a 3/8-inch neoprene buffer pad to absorb irregularities and scuff damage.

F. Flexible Connector: Integrally Molded Outlet
1. PTFE bellows-lined with fiber reinforced composite exterior stainless-steel limit link cables.
2. ANSI 150-pound flange connections
3. Movement capacity:
    a. Axial compression ≥ 0.67"
    b. Axial extension ≥ 0.67"
    c. Lateral deflection ≥ 0.51"
    d. Angular deflection ≥ 14°
    e. Torsional rotation ≥ 4°.
4. Model
    a. Andronaco Industries Company,
    b. Ethylene brand,
    c. Durcor Flexijoint
    d. approved equal.
5. Install expansion joint after the tank shut-off valve, prior to the first pipe support, as close to the tank as possible.

2.8 SOURCE QUALITY CONTROL

A. See Section 014000 “Quality Requirements” for testing, inspection, and analysis requirements.

B. Fabricate like items of the same materials at one shop to standardize quality and appearance in accordance with ASTM D1998.

C. Perform the tests described below on samples from the manway cut out areas or where fittings are inserted in each tank.

D. Testing
   1. Impact Test per ASTM D1998, Section 11.3 at – 20 degrees F. Sample passes if it does not shatter or crack at:
      a. 120 ft/lbs for a 1/2-inch wall thickness
      b. 100 ft/lbs for a wall thickness less than 1/2-inch.
   2. Degree of Crosslinking Test per ASTM D1998, Section 11.4. Sample passes if gel percent is 60 to 70 percent.
   3. Hydrostatic Test. Fill the tank with water to the top of the side wall. Tank passes if there are no leaks after one hour and no significant bulging or shape deformation.
   4. Wall thickness. Measure actual wall thickness measurement at one-foot elevation intervals up to three feet from the bottom of the tank.

E. Prepare and submit complete inspection reports for each tank. Provide, on Owner’s request, a copy of inspection records for review prior to shop inspection by the Owner.

F. Certificate of Compliance
   1. When fabricator is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.
   2. Specified shop tests are not required for Work performed by approved fabricator.

G. Submit Factory Test Report, approved and signed by the Fabricator’s Quality Control Supervisor which includes for each tank:
   1. Inspection records.
   2. Results of hydrostatic testing.
   3. Test reports of physical properties of standard laminates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. See Section 017300 “Execution” for installation examination requirements.

B. Verify that designated areas, clearances, structural requirements, piping, utility connections, and electronic signals are ready to receive equipment.

3.2 PREPARATION

A. See Section 017300 “Execution” for installation preparation requirements.

3.3 INSTALLATION

A. Fabricate equipment and perform Work according to manufacturer instructions .

B. Support Pad: Using templates furnished with tank, install anchor bolts and accessories for mounting and anchoring tank.

C. Install tanks as indicated on Drawings on an even bearing on the concrete pad and/or an HDPE disc provided by the manufacturer and according to manufacturer instructions.

D. Make all pipe connections to tanks as shown on the Drawings, with reducers and flexible connectors as necessary.

E. Install tank accessories not factory mounted to complete installation.

F. Engage the Fabricator to inspect the foundation prior to tank setting and to advise on tank off-loading from the delivery truck.

G. Install anchor bolts, accessories shipped loose, pipe connections, instruments, etc.

H. Support pipes independently of the tank, except where pipe supports are specifically built into the tank.

I. Following the field test and repair of leaks, anchor tanks in their final position according to the Manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

A. See Section 014000 “Quality Requirements” for inspecting and testing requirements.

B. Field Testing
   1. Hydrostatically test each FRP tank by filling with water to the overflow pipe level.
   2. Conduct test minimum 2 hours.
   3. No leakage permitted.

C. Manufacturer Services: Furnish services of manufacturer's representative experienced in installation of products supplied for not less than 2 days on Site for installation, inspection, startup, field testing, and instructing Owner's personnel in operation and maintenance of equipment.

D. Equipment Acceptance: Adjust, repair, modify, or replace components failing to perform as specified and rerun tests.

E. Furnish installation certificate from equipment manufacturer's representative attesting that equipment has been properly installed and is ready for startup and testing.

3.5 FINAL CLEANING

A. After hydrostatic testing, clean the tank with a mild detergent. Do not use abrasives.

B. Rinse with potable water spray and remove all standing water.

3.6 ATTACHMENTS

END OF SECTION 434143

SECTION 460553 - IDENTIFICATION FOR WATER AND WASTEWATER EQUIPMENT

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. Nameplates.
   2. Tags.
   3. Stencils.
   4. Labels.
   5. Lockout devices.

B. Related Requirements:
   1. Section 099000 – Painting and Coating: Execution requirements for painting specified by this Section.

1.3 PREINSTALLATION MEETINGS

A. Section 013100 “Project Management and Coordination”: Requirements for preinstallation meeting.

B. Convene minimum one week prior to commencing Work of this Section.

1.4 SUBMITTALS

A. Section 013300 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit manufacturers catalog literature for each product required.

C. Shop Drawings: Submit list of wording, symbols, letter size, spacing of labels, and color coding for equipment identification and schedule, including equipment number, location, function, and manufacturer's name and model number.

D. Samples: Submit two nameplates, labels, and tags for each size used on Project.

E. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Qualifications Statement:
   1. Submit qualifications for manufacturer.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

A. Manufacturers:
   1. Craftmark Pipe Markers.
   2. Kolbi Pipe Marker Co.
   3. Pipemarker.com (Brimar Industries, Inc.).
   4. Seton Identification Products.
   5. Substitutions: Not permitted.

B. Description: Laminated three-layer plastic with engraved black letters on light, contrasting background color.

2.2 TAGS

A. Plastic Tags:
   1. Manufacturers:
      a. Brady ID.
      b. Craftmark Pipe Markers.
      c. Kolbi Pipe Marker Co.
      d. Marking Services, Inc.
      e. R&R Identification Co.
      f. Seton Identification Products.
      g. Substitutions: Not permitted.
   2. Description:
      a. Laminated three-layer plastic with engraved black letters on light, contrasting background color.
      b. Minimum Tag Size and Configuration: 1-1/2-inch (38-mm) square.
      c. Provide with brass hooks suitable for attaching the tag.
      d. Stamp or etch tags with identifying information on schedule coded in a system provided by the Owner.

B. Metal Tags:
   1. Manufacturers:
      a. Brady ID.
      b. Craftmark Pipe Markers.
      c. Kolbi Pipe Marker Co.
      d. Marking Services, Inc.

e. Pipemarker.com (Brimar Industries, Inc.).
f. R&R Identification Co.
g. Seton Identification Products.
h. Substitutions: Not permitted.

2. Description:
a. Stainless steel construction; stamped letters.
b. Minimum Tag Size and Configuration: 1-1/2-inch (38-mm) square with finished edges.
c. Provide with brass hooks suitable for attaching the tag.
d. Stamp or etch tags with identifying information on schedule coded in a system provided by the Owner.

C. Information Tags:
1. Manufacturers:
a. Brady ID.
b. Seton Identification Products.
c. Substitutions: Not permitted.
2. Description:
a. Clear plastic with printed DANGER, CAUTION, WARNING and message.
b. Minimum Tag Size: 3-1/4 by 5-5/8 inch (83 by 143 mm).
c. Furnish grommet and self-locking nylon ties.
3. Tag Chart: Typewritten, letter-size list of applied tags and location, plastic laminated.

2.3 STENCILS

A. Manufacturers:
1. Kolbi Pipe Marker Co.
2. Marking Services, Inc.
3. Pipemarker.com (Brimar Industries, Inc.).
4. R&R Identification Co.
5. Seton Identification Products.
6. Substitutions: Not permitted.

B. Description:
1. Clean-cut symbols.
2. Letter Height: 1-3/4 inch (44 mm).

C. Stencil Paint: As specified in Section 099000 - Painting and Coating; semi-gloss enamel.

2.4 LABELS

A. Manufacturers:
1. Brady ID.
2. Seton Identification Products.
3. Substitutions: Not permitted.
4. Furnish materials according to City of Flint Michigan standards.

B. Description:
1. Aluminum construction.

2. Minimum Size: 1.9 by 0.75 inch (48 by 19 mm).
3. Adhesive backed, with printed identification.

2.5 LOCKOUT DEVICES

A. Lockout Hasps:
   1. Manufacturers:
      a. Brady ID.
      b. Master Lock Company, LLC.
      c. Substitutions: Not permitted.
   2. Description:
      a. Anodized aluminum construction.
      b. Furnish hasp with erasable label surface.
      c. Minimum Size: 7-1/4 by 3 inches (184 by 76 mm).

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces as specified in Section 099000 - Painting and Coating for stencil painting.

3.2 INSTALLATION

A. Identify equipment with plastic nameplates.

B. Identify inline pumps and other small devices with tags.

C. Identify control panels and major control components outside panels with plastic nameplates.

D. Apply stencil painting as specified in Section 099000 - Painting and Coating.

E. Install identifying devices after completion of coverings and painting.

F. Install plastic nameplates with corrosion-resistant mechanical fasteners or adhesive.

G. Labels:

   1. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.
   2. For unfinished covering, apply paint primer before applying labels.

H. Install tags using corrosion-resistant chain.

END OF SECTION 460553

SECTION 463342 - CHEMICAL FEED EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Sodium hypochlorite, sodium hydroxide (caustic soda), and corrosion inhibitor (orthophosphate blend) chemical metering pump skids complete with all appurtenances shown on the Drawings and as specified herein.
2. Accessories for chemical feed systems including:
   a. Calibration columns
   b. Backpressure / anti-siphon valves
   c. Pressure relief valves
   d. Wye strainers
   e. Miscellaneous chemical service valves
   f. Flexible hoses for chemical systems
   g. Check valves
   h. Flow indicators
   i. Pulsation dampener with charging connection and pressure gauge
3. Sodium hypochlorite, caustic soda, and corrosion inhibitor transfer pumps.

1.2 SYSTEM DESCRIPTION

A. List of new chemical feed systems:
1. Sodium hypochlorite (10-15%)
2. Sodium hydroxide (25%)
3. Corrosion Inhibitor such as orthophosphate blend

B. Pumps and accessories furnished under this Section shall be suitable for use with the following chemicals as appropriate for the intended service:
1. Sodium hypochlorite

Alternate Names:	Bleach Solution
Formula	NaOCl
Concentration	12.5%
Specific Gravity	1.24
Viscosity	2.6 cp
Vapor Pressure	12 - 17 mm Hg @ 20 deg C
pH	12.7
NFPA rating	2 0 1 ox

2. Sodium hydroxide (caustic soda)

Alternate Names:	Caustic Soda
Formula	NaOH
Concentration	25%
Specific Gravity	1.27
Viscosity	7.94 cp
Vapor Pressure	1.5 – 1.6 mm Hg @ 20 deg C
pH	14
NFPA rating	3 0 1

3. Corrosion Inhibitor

Alternate Names:	Inorganic Polyphosphate
Formula	Varies
Concentration	70% as O-PO4
Specific Gravity	1.33 -1.41
Viscosity	10.0 cp
Vapor Pressure	N/A
pH	5.3 to 6.3
NFPA rating	1 0 0

C. Each diaphragm metering pump skid shall be provided with integral calibration column, pressure relief valve, two check valves, PVC Wye strainer, chargeable pulsation dampener, discharge pressure gauge, diaphragm leak detection, and a flow rate indicator. Provide external diaphragm type back pressure/anti-siphon valves and injection check valves at feed points for these chemicals.

D. Contractor shall coordinate chemical metering pump features with each local control panel design.

E. The diaphragm metering pump skid shall be assembled at the factory and delivered intact with minimal field adjustments.

1.3 SUBMITTALS

A. All submittals shall be in accordance with Sections 013300. At a minimum, submittals shall include the following:
   1. Equipment and system information: Shop drawings shall be submitted showing details of fabrication and installation.
   2. Descriptive literature, bulletins, and/or catalogs of the pumps, valves, and accessories.
   3. Data on the characteristics and performance of each pump. Data shall include performance curves of similar units, which show that they meet the specified requirements for fluid, head, capacity, efficiency, NPSHR/NPIPr, and brake horsepower. Curves shall be submitted on 8-1/2-in by 11-in sheets, at as large a scale as is practical.
   4. Complete wiring diagrams and suitable outline drawings showing such details as are necessary to locate conduit stubups and field wiring. Standard preprinted sheets or drawings simply marked to indicate applicability to this Work will not be acceptable.
   5. Pump manufacturer calculations for each metering and transfer pump to determine the suitability of each pump to the suction and discharge conditions of each application point. Factory calculations shall recommend and size an accumulator to be piped to the suction side of each metering pump.
   6. Complete bill of materials and motor data.
   7. Data demonstrating compatibility of the materials of construction and chemicals for all items.
   8. The Contractor shall submit detailed written startup and testing procedures for the chemical equipment furnished. These procedures shall be detailed as to the item and function that will be tested. The test procedures shall test all equipment, instruments and each function thereof, throughout the operating range of the equipment. The procedures shall be separated into a startup and test procedures plan for each chemical system. Provide recommended backpressure and pressure relief valve set points for the equipment being furnished.
   9. Provide resumes for tradespersons that will be involved in the daily construction of chemical feed system as specified in this Section. Documentation shall be used to confirm that personnel have prior experience with construction of the specified chemical

systems. The Engineer has the right to reject or approve the use of the proposed tradespersons based on review of submitted information.

10. Operating and Maintenance Data and Training
    a. Operating manuals covering instructions and maintenance sheets on each type of equipment supplied shall be furnished in accordance with Section 017823.
    b. A factory representative who has complete knowledge of operation and maintenance for each piece of equipment shall provide training as described in Section 01758. Submit training agenda and information.

1.4 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Pack as required for shipping and outdoor storage at the project site for up to 6 months or such greater time as required by the Contractor. Apply temporary corrosion protective coatings to all unpainted components and pack components to protect from the elements.

B. Storage and Protection: Protect the pump system and components at the site and during installation prior to project completion. Apply protective coatings and manually rotate shafts regularly as recommended by the manufacturer.

1.5 MAINTENANCE

A. Tools and Spare Parts
   1. One set of all special tools required for the proper servicing of all equipment supplied under this Section shall be furnished and packed in a suitable steel tool chest with a lock.
   2. For each hydraulic actuated diaphragm metering pump, the spare parts shall be furnished to assure normal operation and maintenance for a period of one year in accordance with the manufacturer's recommendations. As a minimum, the following shall be provided for each type and size of pump:
      a. Two diaphragm and all seals
      b. Two sets of ball checks and seats, and seals
      c. Two can of replacement oils
      d. One set spare fuses

PART 2 - PRODUCTS

2.1 GENERAL

A. Each pumping unit shall be complete including pumps, motors, and appurtenances as an integrated package for proper coordination and compatibility of equipment.

B. The pumps and motors shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating and without excessive vibration or strain.

C. Each chemical metering pump system shall be furnished with a system control panel with VFD for flow pacing.

D. Nameplates of suitable chemical resistance shall be attached to the equipment. The name plates shall provide the following data.
   1. Pump nameplates shall include capacity, head, speed and name and tag number of the respective unit.

2. Motor nameplates shall include horsepower, speed, voltage, amperes, service factor and any other pertinent data.

E. All necessary foundation bolts, nuts and washers shall be furnished and shall be Type 316 stainless steel.

2.2 HYDRAULIC ACTUATED DIAPHRAGM METERING PUMPS

A. Metering pumps shall be positive displacement hydraulically actuated diaphragm type. The pump shall have a volume-measuring piston reciprocating within a cylinder and forcing the hydraulic fluid to flex the diaphragm. The diaphragm shall be returned by hydraulic means. Packed plunger and mechanically actuated diaphragms are not allowed. All pumps shall be of simplex type and be capable of running dry indefinitely.

B. The pump's moving parts shall be enclosed with no opportunity for moving parts to be exposed during operation.

C. The metering pump shall have mechanical lost motion type flow control where the worm gear set actuates a reciprocating piston to drive the hydraulically actuated diaphragm. The stroke adjustment design shall ensure chemical delivery during 100% of each discharge stroke cycle at infinite stroke settings.

D. Diaphragm shall be capable of operating at 100% capacity at full rated pressure for a minimum of 9000 hours of service. The diaphragm shall be capable of sealing under full head-bolt torque limits without stressing the diaphragm. The diaphragm shall be of pre-shaped PTFE composite type. The PTFE shall apply to the process fluid side, and the elastomer shall apply to the hydraulic fluid side.

E. The metered liquid shall enter the metering head at the bottom and exit at the top through the check valves. Pump head shall have suction and discharge ball check valves. Check valves shall be free seating ball-type valves with knife-type contact seats and 4-point guided to control vertical and horizontal movement. Valve and seat shall be cartridge type, individually replaceable and sealed by o-ring or flat gasket. Spring-loaded check valves will not be acceptable.

F. The pump feed rates shall be adjustable by manually changing stoke length or automatically by changing motor speed in response to a 4-20 mA process signal. Adjustment shall be accomplished while the pump is operating. Manual capacity adjustment by changing stroke length from 0 to 100% shall be provided for each pump unit. Capacity controls shall be capable of a 100% duty cycle.

G. Pumps shall have an internal safety relief valve. The valve shall be integrated and field adjustable type relief valve to protect pump from over pressure.

H. The pump materials of construction shall be as follows provided the manufacturer approves of its use for the service chemicals
   1. Pump housing: Cast iron
   2. Diaphragm: PTFE composite
   3. Wet ends: 316 stainless steel
   4. Valves: 316 stainless steel
   5. Valve gaskets: PTFE

I. Each pump shall be supplied with a leak sensing device. The device shall be provided between double diaphragms separated by a hollow intermediate ring. The leak detection system shall include a pressure gauge with pressure switch signal to provide indication and alarm in case of leaks and diaphragm rupture. Local and remote alarms shall be provided in case of diaphragm ruptures.

2.3 PUMP MOTOR AND DRIVE

A. Chemical dosing pump drive motors shall be AC with adjustable speed range capability. The motors shall be inverter duty and meet NEMA MG 1 Part 31.4.4.2, and be operated from a remotely mounted variable frequency drive VFD drive controller. Motors shall be standard totally enclosed fan cooled AC units of the frame size selected by the pump manufacturer to prevent overheating when continuously operated at low speeds.

B. Each motor and controller shall be suitable for continuous operation over a 100:1 range with a flux vector control mode with motor encoder feedback providing constant torque over this range. A thermal switch shall be furnished in each drive motor and shall be field wired to the VFD controller to stop motor on high temperature.

C. Each chemical metering pump shall be furnished with a NEMA 4X control panel. The control panel shall be powered via a 480 volt, 3 phase, 60 Hz power supply. The VFD shall be installed in the respective control panel. Each panel shall also contain a power disconnect switch, power isolating transformer, control power transformer for 120 volt control, and isolating transducer. Mounted on the face of the panel shall be a manual digital speed controller, digital speed indicator, Hand-Off-Auto selector switch, reset pushbutton, red motor running light, and amber alarm lights for motor high temperature, drive failure, leak and high discharge pressure. An auxiliary set of switch contacts shall be provided for the following outputs: H-O-A switch in "Auto" position, pump Running status, High discharge pressure alarm, Leak alarm, and Common pump trouble alarm. In Auto position, the pump shall started and stopped remotely by the plant's SCADA system. Also, in Auto position, the pump speed input can be automatically adjusted (flow paced) or manually adjusted remotely by the SCADA system. Engraved nameplates shall be provided for each device or component face mounted on the control panel. Current limiting input fuses, line reactors, circuit breaker disconnect, motor isolation contactor, control transformer overload relays, process signal follower card and all required relays and terminals shall be provided. Drives and the control panel shall be UL listed.
   1. Minimum Drive Efficiency: 95 percent or better at 4/4 motor base speed and rated torque. Efficiencies shall be based on a centrifugal load condition with current proportional to the square of the speed and shall include all control power and cooling system losses associated with the drive.
   2. Displacement Power Factor: 0.95 or better at any speed, measured at drive input terminals.
   3. Drive Output: 100 percent rated current continuous, suitable for operation of the driven equipment over the full 30:1 speed range without overloading or low speed cogging. Drives shall be capable of a continuous overload up to 110 percent rated current and a maximum 150 percent overload for 1 minute. Starting torque shall be matched to the load.
   4. Voltage Regulation: plus or minus 1 percent of rated value, no load to full load.
   5. Output Frequency Drift: No more than plus or minus 0.5 percent from setpoint.
   6. Drives shall withstand five cycle transient voltage dips of up to 15 percent of rated voltage without an under-voltage trip or fault shutdown, while operating a variable torque load.

7. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controller to any of the following conditions shall not result in component failure or the need for fuse replacement.
   a. Short circuit at controller output
   b. Ground fault at controller output
   c. Open circuit at controller output
   d. Input undervoltage
   e. DC bus overvoltage
   f. Loss of input phase
   g. AC line switching transients
   h. Instantaneous overload
   i. Sustained overload exceeding 115 percent of controller rated current
   j. Over-temperature - responsive to a thermal switch in the motor or an overload relay
8. The controller electronics shall contain light emitting diodes (LED's) or a LED textual display to monitor and indicate the following conditions.
   a. Undervoltage
   b. Overvoltage
   c. Ground Fault
   d. Instantaneous Overcurrent
   e. Overtemperature
   f. Power UP Delay/Reset
   g. Drive Enabled
   h. Bus Capacitors Charged
9. Following an over or under voltage trip, the drive shall automatically restart after a short time delay after the incoming line voltage trip.
10. Drive manufacturing factory shall be certified to the ISO-9001 Series of Quality Standards and the ISO-14001 Environmental Standards. The variable speed drive shall be Rockwell Automation, Allen-Bradley or approved equal.

2.4 CHEMICAL FEED SYSTEM ACCESSORIES

A. Calibration Columns
   1. General: For each service provide a calibration column of height and diameter such that the measurable capacity of the column is as noted below. Permanently calibrate and mark each column in milliliters. Height and diameter shall be sized such that the measurable capacity of the chamber is at least 45 seconds at maximum pumping capacity. Fittings shall be solvent weld, threaded, or flanged as shown on the Drawings. Top and bottom caps shall be sealed and include the same size female NPT connections top and bottom. Calibration chambers shall be rigidly installed, not supported from the piping system. Pump suction and discharge pipe shall be arranged so as not to interfere with location and use of the calibration columns. Calibration columns to be by Pulsafeeder, Griffco Valve Inc., or equal.
   2. Sodium hypochlorite service: Clear PVC cylinder and fittings shall be Schedule 80. Column capacity: 1,000 mL
   3. Sodium hydroxide (caustic soda) service: Clear PVC cylinder and fittings shall be Schedule 80. Column capacity: 1000 mL.
   4. Corrosion Inhibitor: Clear PVC cylinder and fittings shall be Schedule 80. Column capacity: 200 mL.

B. Backpressure/Anti-siphon Valves
   1. General: Backpressure valves shall have a suitable range for the metering pump and chemical system application. Valves shall be field adjustable with initial setting

established, tested, and labeled on the valve at the factory. Valve manufacturer shall confirm materials of construction for each service. Non-wetted fasteners shall be stainless steel. C. Pressure Relief Valves

2. General: Pressure relief valves shall have a suitable range for the metering pump and chemical system application. Valves shall be field adjustable with initial setting established, tested, and labeled on the valve at the factory. 2.

C. Wye Strainer

1. General: Wye strainers shall have flanged or screwed ends to remove the strainer screen without removing the valve body from piping. Strainers shall be one size larger than the suction line in which they are installed. Non-wetted fasteners shall be Type 304 or 316 stainless steel. Strainers shall be 20 mesh and compatible with the chemical. Strainers shall be manufactured by Asahi-America, Georg Fischer, or equal.
2. Sodium hydroxide (caustic soda) service: Valve body clear PVC; chemically compatible O-rings.

D. Miscellaneous chemical service valves

1. General: Miscellaneous chemical service valves shall be provided as included in the Drawings or as necessary for proper functioning of the system. Miscellaneous chemical service valves shall be by Asahi-America, IPEX, or equal.

E. Flexible Hose for Chemical Service

1. Flexible hoses for chemical service shall be of materials compatible with the service and concentrations. Hose ends shall be flanged unless otherwise shown on the Drawings. PVC flanges shall have stainless steel follower rings. Lengths shall be as shown on the Drawings or as required (else an 18-inch minimum length). Hoses shall be food grade or NSF 61 approved. Manufacturer to confirm chemical compatibility for all components. Hoses shall be by Page International, Microflex, Kanaflex, RyanHerco, or equal.
2. Flexible hoses for other uses shall be compatible with the chemical service. If no service is specified provide helical reinforced heavy duty clear PVC hose with smooth interior surfaces, 100 psig minimum working pressure, with Type 304 stainless steel end adapters. Hoses shall be by Page International, Microflex, Kanaflex, or equal.

F. Contractor shall provide a spill containment bucket for each chemical fill station. Each bucket shall have a 5 gallon capacity and constructed of compatible plastic material.

2.5 TRANSFER PUMPS

A. Transfer pumps shall be provided for sodium hypochlorite, sodium hydroxide, and the corrosion inhibitor between each chemical's bulk storage and day tank. Each transfer pump shall be of ductile iron-jacketed, non-metallic lined, magnetic drive, sealless process centrifugal pumps, capable of continuous service with the specified chemicals. Pump design shall be modular with casing liners, impellers, bearings, and thrust surfaces being individually replaceable. The electric motor shall be close coupled to the pump. Electric motors shall be of standard NEMA design and frame designation. Motors shall be 115 volt, 1 phase, 60 hertz and shall be rated for TEFC severe duty.

B. All wetted parts shall be compatible with the chemical.

C. The electric motor and pump/motor magnetic coupling shall be designed to be non-overloading throughout the entire pump curve for a given impeller diameter. The magnetic coupling sizing by the manufacturer shall take into account each chemical's specific gravity and viscosity, eddy current losses, total dynamic head, and piping geometry.

D. Each pump shall be capable of handling each chemical up to a maximum temperature of 45 degrees C. All wetted surfaces shall be non-metallic and compatible with the specified chemical. The liner, impeller, and driven magnet encapsulation shall be ethylene-tetrafluorethylene copolymer (ETFE). A low flow switch shall be used to protect the pump against no- and low-flow conditions. Provide carbon bushings for maximum dry run protection.

E. Suction and discharge connections shall be ANSI 150# flat face flanges.

F. Pumps shall be Iwaki America, Magnatex Pumps, or equal.

G. Sodium hypochlorite service (P-1210 and P-1220): The design point for each pump is 12.5 gpm at 36 feet TDH. Suction size shall be 1-inch and discharge size shall be 1.0-inch.

H. Sodium hydroxide (caustic soda) service (P-2210 and P-2220): The design point for each pump is 10.5 gpm at 37 feet TDH. Suction size shall be 1-inch and discharge size shall be 1.0-inch.

I. Corrosion Inhibitor service (P-3210 and P-3220): The design point for each pump is 12.5 gpm at 36 feet TDH. Suction size shall be 1-inch and discharge size shall be 1.0-inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The equipment, including pump bases, shall be anchored into position and all necessary foundation bolts, plates, nuts and washers shall be furnished and installed by the Contractor. Anchor bolts shall be of Type 316 stainless steel.

B. The chemical metering pumps and appurtenances shall be installed in accordance with manufacturer's instructions and recommendations in locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the recommendations of the manufacturer. Anchor bolts shall be set in accordance with the shop drawings.

C. The diaphragm metering pump skids shall be factory tested and certified before shipment.

D. See Section 463341 for requirements for mock-ups of metering pump piping for each type of chemical and for piping layout shop drawings.

3.2 SURFACE PREPARATION AND PAINTING

A. All external surfaces of pumps, motors and other manufactured items surfaces shall be prepared and painted as specified in Section 099100. Pumps and motors shall be factory finish coated.

3.3 FIELD TESTING

A. Working under the direction of the manufacturer's representatives, the Contractor shall conduct in the presence of the Engineer such tests as are necessary to indicate that each item of equipment conforms to the Specifications.

B. Acceptance Testing: As specified in Section 016650.

C. If the performance of any item of equipment does not meet the Specifications, take corrective measures or remove the unit and replace with one which satisfies the conditions specified.

D. All chemical metering and transfer pumps shall be field calibrated in the presence of the Engineer at 10, 25, 50, 75 and 100 percent of stroke and speed. Six sets of calibration curves shall be provided.

E. Test all equipment including metering pumps and recirculation pumps in all operating scenarios (manual, automatic, run, off, auto, etc.). Metering pumps shall be tested at setting of 10%, 50% and 100% of the full range for both stroke and speed as applicable.

3.4 MANUFACTURER'S FIELD SERVICE

A. Require manufacturer to inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up as specified in this section and in Sections 016650. Manufacturer shall troubleshoot equipment and products furnished under this Section and aid in establishing valve and operational setpoints.

B. Training: As specified in Section 01758 and this Section.

3.5 PUMP SCHEDULES

A. Motor Driven Metering Pump Schedule:

1. Sodium hypochlorite metering pumps, Milton-Roy, Pulsafeeder or equal:

Pump No.	Capacity Range (gph)	Model	Motor (rpm)	Max Motor Hp
P-1610 and P-1620	0.8 – 11.7	mRoy Model A	1725	1

2. Sodium hydroxide (caustic soda) metering pumps:

Pump No.	Capacity Range (gph)	Model	Motor (rpm)	Max Motor Hp
P-2610 and P-2620	1.2 – 10.9	mRoy Model A	1725	1

3. Corrosion Inhibitor:

Pump No.	Capacity Range (gph)	Model	Motor (rpm)	Max Motor Hp
P-3610 and P-3620	0..18 – 2.1	mRoy Model A	1725	1

B. Transfer Pump Schedule:

1. Sodium hypochlorite transfer pumps, Iwaki America, Magnatex Pumps, or equal:

Pump No.	Design Flow (gpm)	Model	Max Motor Hp
P-1210 and P-1220	12.5	Iwaki America MX-250	0.5

2. Sodium hydroxide (caustic soda) transfer pumps:

Pump No.	Design Flow (gpm)	Model	Max Motor Hp

P-2210 and P-2220	10.5	Iwaki America MX-250	0.5

3. Corrosion Inhibitor transfer pumps:

Pump No.	Design Flow (gpm)	Model	Max Motor Hp
P-3210 and P-3220	12.5	Iwaki America MX-250	0.5

END OF SECTION 463342