CONTRACT DOCUMENTS FOR
CONSTRUCTION OF THE

HUIE WETLANDS CHEMICAL FEED

Prepared for

Clayton County Water Authority
Clayton County, Georgia

Volume 1 of 2
Specifications

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Jacobs

JACOBS Project No. EEXJ6915

FEBRUARY 2022

BID DOCUMENTS

CLAY COUNTY WATER AUTHORITY (CCWA)

CLAY COUNTY, GEORGIA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

HUIE WETLANDS CHEMICAL FEED

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JACOBS

February 2022

Project No. EEXJ6915 Copy No._____

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CLAY COUNTY, GEORGIA

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richard thomas morrison

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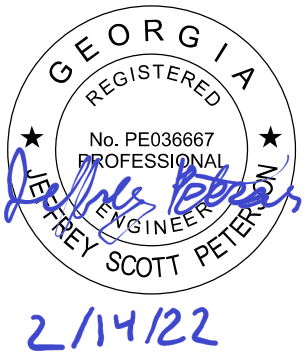

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SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual Specification section.

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Furnish manufacturers' services, when required by an individual Specification section, to meet the requirements of this section.

B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.

C. Schedule manufacturer' services to avoid conflict with other onsite testing or other manufacturers' onsite services.

D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.

E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.

F. When specified in individual Specification sections, manufacturer's onsite services shall include:

1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing copies of manufacturers' representatives field notes and data to Owner.
4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
6. Assistance during functional and performance testing, and facility startup and evaluation.
7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.

B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.03 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is part of this Specification.

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

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

(Check Applicable)

☐ Installed in accordance with Manufacturer's recommendations.

☐ Inspected, checked, and adjusted.

☐ Serviced with proper initial lubricants.

☐ Electrical and mechanical connections meet quality and safety standards.

☐ All applicable safety equipment has been properly installed.

☐ Functional tests.

☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

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

Date: _____, 20___

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section covers work necessary for stabilization of soil to prevent erosion before, during and after construction and land disturbing activities. The work shall include the furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified and as indicated on the approved Drawings. This shall include installation, maintenance, and final removal of all temporary soil erosion and sediment control measures and installation of permanent soil erosion control practices.

B. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. The right is reserved to modify the use, location, and quantities of soil erosion and sediment control measures based on activities of the Contractor and as the Engineer considers to be to the best interest of the Owner.

C. See additional information noted on the Drawings.

D. Erosion, sediment, and pollution control practices shall comply with the "Manual for Erosion and Sediment Control in Georgia," latest edition, this Specification section, and the Drawings. In the event of conflicts, the most stringent requirement shall prevail.

1.02 DEFINITIONS

A. BMP: Best management practice. Means schedule of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, and waste disposal.

B. Certified Contractor: A person who has received training and is a certified professional to install/construct, inspect and maintain erosion and sediment control practices.

C. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

D. Construction Exit: A stone stabilized pad located at any point where traffic will be leaving a construction site to a public right-of-way, street, alley, sidewalk, or parking area or any other area where there is a transition from bare soil to a paved area.

E. ES&PC: Erosion, sediment and pollution control. Any temporary or permanent measures that prevent or reduce erosion, control sedimentation, and ensure that sediment does not leave a site.

F. Land Disturbing Activity: Any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to demolition, construction, clearing, grading, excavation and filling.

G. Maintenance Period: Maintenance period begins immediately after each area is planted and shall continue for a period of 8 weeks after all seeding, sodding, and planting are completed.

H. Project Limits: Areas, as shown or specified, within which Work is to be performed.

I. Sediments: Soil, sand, and minerals washed from land into water, usually after a rain event.

J. Standard Specifications: When referenced in this section, shall mean the current edition of the State of Georgia, Department of Transportation, Standard Specifications for Construction of Transportation Systems. When reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the most stringent requirements shall prevail.

1.03 GENERAL

A. All activities shall conform to the “Manual for Erosion and Sediment Control in Georgia,” latest edition, Gwinnett County permit requirements for land disturbance activities, and the Drawings. In the event of a conflict, the more stringent requirement shall apply.

B. Land disturbance activities shall not commence until the Land Disturbance Permit has been issue.

C. The escape of sediment from the site shall be prevented by the installation of Erosion and Sediment Control measures and practices prior to, and concurrent with land disturbing activities for the entire duration of the project.

D. Erosion and sediment control practices shall be installed and inspected/approved prior to commencement of land disturbance activities.

E. Soil erosion stabilization and sedimentation control consist of, but not limited to, the following elements:

1. Conducting earthwork and excavation activities in such a manner to fit the topography soil type and condition.
2. Implementation and continuous maintenance of BMP's.
3. Minimize disturbed area and duration of exposure to erosion elements.
4. Stabilize disturbed areas immediately:
    a. Topsoil and seeding:
        1) Placement and maintenance of Temporary Seeding on all areas disturbed by construction.
        2) Placement of permanent topsoil, fertilizer, and seed, etc., in all areas not occupied by structures or pavement, unless shown otherwise.
    b. Soil Stabilization Seeding: Placement of fertilizer and seed, etc., in areas as specified hereinafter.
5. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
6. Construction of new permanent and temporary storm drainage piping and channel systems, as necessary.
7. Construction or installation of temporary erosion control facilities such as inlet sediment traps, silt fences, check dams, diversion dikes, construction exit, etc.
8. Construction or installation of permanent erosion control facilities such as check dams, channel stabilization, rip-rap outlet protection, permanent vegetation, etc.

F. Contractor shall install and add to the erosion control measures as determined by the Engineer, Owner, or the County.

G. The Contractor shall be responsible for phasing Work in areas allocated for his exclusive use during this Project, including any proposed stockpile areas, to restrict sediment transport. This will include installation of any temporary erosion control devices, ditches, or other facilities.

H. The areas set aside for the Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be done in a manner to both control all sediment transport away from the area.

I. Contractor is responsible for maintaining all erosion control measures installed for the full duration of this Contract.

J. Contractor shall observe the approved Project sequence. The Contractor shall maintain careful scheduling and performance to ensure that the exposure of land area stripped of its natural cover is kept to a minimum.

K. Prior to commencing land disturbance activities, the Contractor shall clearly and accurately demarcate the limits of land disturbance with clearing fence other appropriate means, for the entire duration of the Project.

L. No land disturbance shall occur outside the approved limits indicated in the approved Drawings.

M. After installation of the initial erosion and sediment control measures, the Contractor shall schedule an inspection with the Engineer and the County's site inspector. No other construction activities shall occur until the Engineer approves the installation of the initial erosion and sediment control measures. If unforeseen conditions exist in the field that warrants the installation of additional erosion and sediment control measures, the Contractor must install any additional measures deemed necessary by the Engineer.

N. The location of some erosion and sediment control measures may have to be altered from those shown on the approved Drawings if drainage patterns during construction differ from the ones shown on the Drawings. Contractor is responsible to accomplish erosion and sediment control for all drainage patterns created during various stages of construction. Contractor shall report to the Engineer any difficulty in controlling erosion during any phase of construction.

O. Mulch or temporary seeding shall be applied to all disturbed areas within 7 days of clearing. All disturbed areas that are stabilized with mulch shall be stabilized with temporary seeding after 30 days.

P. Areas opened by construction operations and that are not anticipated to be re-excavated or dressed and received final grassing treatment within 30 days shall be temporary seeded with a quick growing grass species which will provide an early cover during the season in which it is planted and will not compete with the permanent grassing.

Q. Earthwork operations in the vicinity of stream buffers shall be carefully controlled to avoid dumping or sloughing into the buffer.

R. Inlet sediment protection shall be installed on all stormwater structures as they are constructed and as shown on the Drawings. Sediment shall not be washed into inlets.

S. Upon completion of construction, the Contractor shall remove all temporary erosion control measures and dispose of them, unless noted on the Drawings. Permanent seeding shall be applied to the entire Site for all remaining area.

T. The Contractor shall maintain all elements of the Soil Erosion Stabilization and Sedimentation Control systems and facilities to be constructed during this Project for the duration of his activities on this Project until permanent stabilization of the Site is achieved.

U. Contractor shall inspect erosion and sediment control measures each day to ensure that they are working properly. Formal inspections made jointly by the Contractor and the Engineer shall be conducted, at a minimum, every 2 weeks to evaluate the Contractor's conformance to the requirements of these Specifications, Clayton County regulations, and the Manual for Erosion and Sediment Control in Georgia.

V. Silt fence shall be inspected for depth of sediment, tears, to see if fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground. Built up sediment shall be removed from silt fence when it has reached one-half the height of the fence.

W. Sediment shall be removed from the retrofitted ponds when one-third of the sediment storage capacity has been reached.

X. Temporary and permanent seeding and planting shall be inspected for bare spots, washouts, and healthy growth. All the permanent seeded grass cover areas shall be reworked and reseeded if 75 percent grass cover is not achieved within 14 days.

Y. If full implementation of the approved Drawings does not provide for effective erosion and sediment control, additional measures shall be implemented as directed by the Engineer.

Z. Contractor's failure to install, operate and maintain all erosion and sediment control measures, to the satisfaction of the Engineer, will result in all construction being stopped on the job until such measures are installed or returned to their proper functional condition.

AA. A maintenance inspection report shall be made after each inspection by the Contractor. The reports will be kept onsite during construction and available upon request by the Owner, the Engineer, the County, or any Federal or Local Agency approving erosion and sediment control plans.

1.04 SUBMITTALS

A. Submittals shall be made for the following:

1. Shop Drawings.
2. Product Data.

B. In addition, the Contractor shall provide the following specific information:

1. Erosion and Sediment Control Plans identifying any field changes.
2. Supporting calculations from any deviation from the approved ESC plans.
3. Sequence and schedule of activities; such as ESC installation, ESC maintenance, site clearing, grading, construction activities, construction of utilities, infrastructure and buildings, final grading, and temporary and final stabilization and removal of all ESC measures.
4. Schedule shall identify the expected date and duration of each activity.
5. Copy of Land Disturbance Permit.

PART 2 PRODUCTS

2.01 SILT FENCE

A. Sensitive Area silt fence in accordance with the “Manual for Erosion and Sediment Control in Georgia,” latest edition and Section 171 of the Department of Transportation, State of Georgia, Standard Specifications, latest edition.

B. Approved products are listed in the Georgia Department of Transportation Qualified Products list No. 36.

2.02 TEMPORARY SEED

A. In accordance with the “Manual for Erosion and Sediment Control in Georgia,” latest edition.

2.03 TOPSOIL

A. Topsoil shall be as specified under Section 32 91 13, Soil Preparation.

2.04 FERTILIZER

A. As specified in Section 32 92 00, Turf and Grasses and in the “Fertilizer Requirements” schedule shown in ESC plans.

2.05 LIME

A. As specified in Section 32 91 13, Soil Preparation.

2.06 ORANGE BARRIER FENCE

A. Ultraviolet stabilized polyethylene or polypropylene safety fence, 3 feet in height, and yellow or orange in color.

2.07 WATER FOR DUST CONTROL

A. Free of hazardous or toxic contaminates.

2.08 STONE FOR CONSTRUCTION EXIT

A. Crushed stone with particle size ranging from 1.5 inches to 3.5 inches.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall install erosion and sediment control measures and maintain in accordance with the Drawings. The sequence of construction shown on the Drawings is made a part of these Contract Documents.

B. The Contractor shall provide and maintain soil stabilization at all times.

C. After installation of the initial erosion and sediment control measures, the Contractor shall schedule an inspection with the Engineer and the Owner's site inspector. No other construction activities shall occur until the Engineer approves the installation of the initial erosion and sediment control measures. If unforeseen conditions exist in the field that warrants the installation of additional erosion and sediment control measures, the Contractor must install any additional measures deemed necessary by the Engineer.

D. Contractor shall observe the approved Project sequence. The Contractor shall maintain careful scheduling and performance to ensure that the exposure of land area stripped of its natural cover is kept to a minimum.

E. Inlet sediment protection shall be installed on all existing and proposed stormdrain structures as shown on the Plans. Sediment shall not be washed into inlets.

3.02 SILT FENCE

A. The Contractor shall construct silt fence Sd1-S in accordance with the "Manual for Erosion and Sediment Control in Georgia," latest edition.

3.03 SEEDING

A. General:

1. The Contractor shall give at least 3 days' notice to the Engineer prior to seeding to allow for inspection of the areas. The Contractor shall rework any areas not approved for seeding to the Engineer's satisfaction.
2. The Contractor shall keep the Engineer advised of schedule of operations.
3. Seed shall be clean, delivered in original unopened packages and bearing an analysis of the contents, guaranteed 95 percent pure with minimum germination rate of 85 percent.

B. Schedules: Seeding shall be performed in accordance with the "Manual for Erosion and Sediment Control in Georgia," latest edition.

C. Soil Stabilization and Temporary Seeding:

1. Soil stabilization seeding shall consist of the application of the following materials in quantities as further described herein for stockpiles and disturbed areas left inactive for more than 14 days.
   a. Lime.
   b. Fertilizer.
   c. Seed.
   d. Mulch.
   e. Maintenance.
2. Hydroseeding will be permitted as an alternative method of applying seed and associated soil conditioning agents described above. Should the Contractor elect to apply soil stabilization seeding by hydroseeding methods, he shall submit his operational plan and methods to the Engineer.
3. Temporary Seeding is to be placed and maintained over all disturbed areas prior to sodding. Maintain Temporary Seeding until such time as areas are approved for sodding. As a minimum, maintenance shall include the following:
   a. Fix-up and reseeding of bare areas or redisturbed areas.
   b. Mowing for stands of grass or weeds exceeding 6 inches in height.

3.04 DUST CONTROL

A. Contractor shall control, at all times, surface and air movement of dust.

B. Sprinkler site with water until the surface is wet. Repeat as needed.

3.05 CONSTRUCTION EXIT

A. Construct a Construction Exit to allow for removal of mud from the tires.

B. Provide a stone stabilized pad at location(s) shown on Approved Drawings, as follows:

1. Width: 20 feet minimum.
2. Length: 50 feet minimum.
3. Thickness: 6 inches minimum.

C. Provide a non-woven geotextile underliner.

D. If the action of the vehicle traveling over the stone pad does not sufficiently remove the mud, the tires should be washed prior to entrance onto public rights-of-way.

E. When washing is required, it shall be done on an area stabilized with crushed stone and provisions that intercept the sediment-laden runoff and direct it into an approved sediment trap or sediment basin.

3.06 STORM DRAIN INLET PROTECTION

A. Install storm drain inlet protection around all storm drain inlets that are within 200 feet of the limits of construction to trap sediment.

B. Filter Fabric with Supporting Frame:

1. Provide silt fence with supporting frame around inlets.
2. The stakes shall be spaced evenly around the perimeter of the inlet a maximum of 3 feet apart, and securely driven into the ground, approximately 18 inches deep.
3. The silt fence fabric shall be entrenched 12 inches and backfilled with crushed stone or compacted soil.
4. Fabric and wire shall be securely fastened to the posts, and fabric ends must be overlapped a minimum of 18 inches or wrapped together around a post to provide a continuous fabric barrier around the inlet.

C. Approved alternate product for pedestal top inlet protection.

3.07 FIELD QUALITY

A. Upon completion of maintenance period and on written notice from the Contractor, the Engineer will within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, the Engineer will make another determination upon written notice from Contractor following the next growing season.

3.08 MAINTENANCE OF EROSION AND SEDIMENT CONTROL MEASURES

A. Erosion and sediment control measures shall be maintained at all times until permanent stabilization of the site is achieved.

B. Erosion and sediment control measures shall be checked after each rain event, and shall be immediately repaired or replaced if found to be defective. A record shall be maintained of all inspections, repairs and replacement.

C. Contractor shall inspect erosion and sediment control measures each day to ensure that they are working properly.

D. Construction exit shall be top dressed with additional material periodically to maintain minimum depth of 6 inches. All materials spilled, dropped, washed, or tracked from vehicles or site onto roadways or into storm drains must be removed immediately.

E. Silt fence shall be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground. Build up sediment shall be removed from silt fence when it has reached on-half the height of the fence.

F. Each BMP is to be maintained or replaced if the accumulated sediment depth is equal to or greater than one-half of the capacity of the device. Reference marks denoting the elevation at which each device is to be maintained shall be placed on all devices.

G. Temporary and permanent seeding, sodding, and planting shall be inspected for bare spots, washouts, and healthy growth. All the permanent seeded grass cover areas shall be reworked and reseeded if 75 percent grass cover is not achieved within 14 days.

H. If full implementation of the approved Plans does not provide for effective erosion and sediment control, additional ESC measures shall be implemented as directed by the Engineer or Owner.

I. A maintenance inspection report shall be made after each inspection by the Contractor. The reports will be kept onsite during construction and available upon request by the Engineer, Owner, or any Federal, State, or Local Agency. The report shall identify any incidents of non-compliance.

J. Contractor shall installed and add to erosion control measures as determined by the Engineer or the Owner.

K. The Contractor shall maintain all elements of the ESC measures and facilities to be constructed during this Project for the duration of his activities on this Project. Formal inspections made jointly by the Contractor and the Engineer shall be conducted every 2 weeks to evaluate the Contractor's conformance to the Approved Drawings and this Specification.

L. All silt traps shall be cleaned of collected sediment after every storm or as determined from the biweekly inspections. Cleaning shall be done in a manner that will not direct the sediment into the storm drain piping system. Removed sediment shall be taken to an area selected by the Engineer where it can be cleaned of sticks and debris, then allowed to dry. Final sediment and debris disposal shall be onsite as designated by Engineer.

M. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion control devices shall be accomplished by the Contractor within 2 days after receiving written notice from the Engineer.

N. Unpaved earth drainage ditches shall be regraded as needed to maintain original grade and remove sediment buildup. If a ditch becomes difficult to maintain, the Contractor shall cooperate with the Engineer and install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by the Engineer.

O. If the Contractor has not complied with any of the above maintenance efforts to the satisfaction of the Engineer within 2 working days after receiving written notification from the Engineer, the Owner shall have the prerogative of engaging others to perform any needed maintenance or cleanup, including removal of accumulated sediment at constructed erosion control facilities, at Contractor's expense.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, purchased the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 DESIGN REQUIREMENTS

A. Where Contractor and/or Manufacturer design is specified, design of installation, systems, equipment, and components, including supports and anchorage, shall be in accordance with provisions of 2018 International Building Code (IBC) by International Code Council, as amended by the State of Georgia in 2020, Occupational Health and Safety Administration, and all other requirements by state and applicable local agencies.

1. Refer to the General Structural Notes on the Drawings for Project-specific design criteria.
2. Refer to individual Specification sections and to the Drawings for additional design criteria.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Altitude: Provide materials and equipment suitable for installation and operation under rated conditions at 1,000 feet above sea level.

B. Provide equipment and devices installed outdoors or in unheated enclosures capable of continuous operation within an ambient temperature range of 0 degrees F to 120 degrees F.

1.04 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.

C. Extra Materials, Special Tools, Test Equipment, and Expendables:

1. Furnish as required by individual Specifications.
2. Schedule:
    a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
    b. Transfer to Owner shall occur immediately subsequent to Contractor’s acceptance of equipment from Supplier.
3. Packaging and Shipment:
    a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
    b. Prominently displayed on each package, the following:
        1) Manufacturer’s part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
        2) Applicable equipment description.
        3) Quantity of parts in package.
        4) Equipment manufacturer.

D. Request a minimum 7-day advance notice of shipment from manufacturer.

E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.05 DELIVERY AND INSPECTION

A. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.

B. Deliver products in undamaged condition, in manufacturer’s original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.

C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.

D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.06 HANDLING, STORAGE, AND PROTECTION

A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.

C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.

D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.

E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.

G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.

H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.

C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.

D. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.

E. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.

F. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.

G. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

H. Equipment Finish:

1. Provide manufacturer's standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with gray finish as approved by Owner.

I. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

J. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.

B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).

C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor’s control.

3.02 MANUFACTURER’S CERTIFICATE OF COMPLIANCE

A. When so specified, a Manufacturer’s Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.

B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

B. No shimming between machined surfaces is allowed.

C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Repaint painted surfaces that are damaged prior to equipment acceptance.

E. Do not cut or notch any structural member or building surface without specific approval of Engineer.

F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.

3.04 FIELD FINISHING

A. In accordance with individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENTS

A. The supplement listed below, following "End of Section", is part of this Specification.

1. Form: Manufacturer's Certificate of Compliance.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2018 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

C. Component Important Factor:

1. Ip = 1.0, unless noted otherwise.
2. Ip shall be taken as 1.5 if any of the following conditions apply:
   a. Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
   b. Component contains hazardous materials.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional structural engineer registered in the State of Georgia.
2. Design anchorage into concrete including embedment in accordance with ACI 318-14; Chapter 17 (or other industry standard approved by Engineer), and Project Specifications.
3. Design anchorage and bracing of mechanical and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential mechanical, or electrical equipment.
6. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
7. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
8. Design seismic anchorage and bracing for:
    a. Equipment with Component Importance Factor greater than 1.0.
    b. Equipment weighing more than 20 pounds.
9. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on the Drawings for exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
3. Operational:
    a. For loading supplied by equipment manufacturer for IBC required load cases.
    b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.

c. Locate braces to minimize vibration to or movement of structure.
d. Use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors.

4. Seismic:
   a. In accordance with 2018 IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on the Drawings.
   c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 or IBC Section 1905.1.8 as applicable for Project Seismic Design Category.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturers' engineered seismic and non-seismic hardware product data.
   b. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   c. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on the Drawings, in addition to manufacturer's specific criteria used for design; sealed by a structural engineer registered in the State of Georgia.
2. Manufacturer's hardware installation requirements.

1.06 SOURCE QUALITY CONTROL

A. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on the Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.

D. Do not use powder-actuated fasteners

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

D. Do not attach mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors**.**

B. Provide any specified, regulatory required, or required repair verification inspection and testing.

END OF SECTION

SECTION 03 30 10
STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 GENERAL

A. Work shall conform to requirements of ACI 301, Specifications for Structural Concrete, unless otherwise specified.

1.02 REFERENCES

A. In accordance with ACI 301 and the following:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 305.1, Specification for Hot Weather Concreting.
   c. 306.1, Specification for Cold Weather Concreting.
   d. 308.1, Specification for Curing Concrete.
   e. SP-66, Detailing Manual.
2. ASTM International (ASTM):
   a. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
   b. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.Placing Reinforcing Bars.
   b. ANSI/CRSI – RB 4.1, CRSI Standard for Supports for Reinforcement Used in Concrete.
4. National Ready Mixed Concrete Association (NRMCA).

1.03 DEFINITIONS

A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

B. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

C. Exposed Concrete: Concrete surface that can be seen inside or outside of structure.

D. Hot Weather: As defined in ACI 305.1.

E. New Concrete: Concrete less than 60 days old.

F. Top Bars: Horizontal bars placed such that 12 inches of fresh concrete is cast below in single placement.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Formwork and Formwork Accessories: Unless otherwise specified, conform to requirements of ACI 301.
   b. Reinforcing steel prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66 Detailing Manual:
      1) Bending lists.
      2) Placing drawings.
   c. Construction Joints, Expansion Joints, and Control Joints: Layout and location for each type.
2. Mix Design:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common product Requirements, for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Aggregates, including specified class designation for coarse aggregate.
      5) Admixtures.
      6) Concrete producer has verified compatibility of constituent materials in design mix.
   d. Test Reports:
      1) Cement: Chemical analysis report.
      2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.

3) Aggregates:
   a) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
   b) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
4) Water-Soluble Chloride-Ion Content in Hardened Concrete: One of the following:
   a) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
   b) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
   c) All of the following:
      (1) Manufacturer's Certificate of Compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
      (2) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
      (3) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.
5) Alkali Aggregate Reactivity: Where required, in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.

e. Product Data:
   1) Admixtures: Manufacturer's product data sheets for each admixture used in proposed mix designs.

3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
   a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
   b. Documentation of embeds that must be at a temperature above freezing prior to placement of concrete.
   c. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.

d. Methods for temperature protection during placement.
e. Types of covering, insulation, housing, or heating to be provided.
f. Curing methods to be used during and following protection period.
g. Use of strength accelerating admixtures.
h. Methods for verification of in-place strength.
i. Procedures for measuring and recording concrete temperatures.
j. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot-weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
   a. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
   b. Use of retarding admixture.
   c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
   d. Types of shading and wind protection to be provided.
   e. Curing methods, including use of evaporation retardant.
   f. Procedures for measuring and recording concrete temperatures.
   g. Procedures for preventing drying during dry, windy conditions.
5. Concrete repair techniques.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer’s application instructions for bonding agent and bond breaker.
3. Manufacturer’s Certificate of Compliance to specified standards:
   a. Bonding agent.
   b. Bond breaker.
   c. Repair materials.
4. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
5. Manufacturer’s written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Joint filler and primer.
   b. Preformed control joint.

6. Concrete Delivery Tickets:
    a. For each batch of concrete before unloading at Site.
    b. In accordance with ASTM C94/C94M, including Requirement 14.2.1. through Requirement 14.2.10.
    c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work.
3. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
    a. Where field testing is required, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
    b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician–Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician–Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Contractor, including pumping, placing and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Testing and sampling personnel.
    e. Steel Reinforcement Installer
    f. Engineer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.

3. Agenda shall include:
    a. Admixture types, dosage, performance, and redosing at Site.
    b. Mix designs, test of mixes, and Submittals.
    c. Placement methods, techniques, equipment, consolidation, and form pressures.
    d. Slump and placement time to maintain slump.
    e. Finish, curing, and water retention.
    f. Steel reinforcement details.
    g. Protection procedures for weather conditions.
    h. Other specified requirements requiring coordination.
4. Conference minutes.

PART 2 PRODUCTS

2.01 FORMWORK

A. Form Materials:

1. For exposed areas, use hard plastic finished plywood, overlaid waterproof particle board, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish.
2. For unexposed areas, use new shiplap or plywood.
3. Earth cuts may be used for forming footings.

B. Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

2.02 CONCRETE

A. Materials:

1. Cementitious Materials:
    a. Cement:
        1) Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
        2) Blended Hydraulic Cement:
            a) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
            b) Portland cement used in blended hydraulic cement; conform to requirements of ASTM C150/C150M.
        3) Furnish from one source.

b. Supplementary Cementitious Materials (SCM):
1) Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
a) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
2) Slag Cement: In accordance with ASTM C989/C989M, Grade 100 or Grade 120.

2. Aggregates: Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
a. Aggregates:
1) In accordance with ASTM C33/C33M, except as modified herein.
a) Class Designation: 4M, unless otherwise specified.
b) Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
c) Alkali Silica Reactivity: See Article Concrete Mix Design.
2) Fine Aggregates:
a) In accordance with ASTM C33/C33M, except as modified herein.
b) In the event manufactured sand is included in the mix design, the material shall be from the same source as the coarse aggregate.
c) Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
(1) Limit material finer than 75-µm (No. 200) sieve to 3 percent mass of total sample.
(2) Limit coal and lignite to 0.5 percent.
3) Coarse Aggregate:
a) Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
b) Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.

3. Admixtures:
a. Characteristics:
1) Compatible with other constituents in mix.
2) Contain at most, only trace amount chlorides in solution.
3) Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.

b. Air-Entraining Admixture: ASTM C260/C260M.
c. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
d. Retarding Admixture: ASTM C 494/C 494M, Type B.
e. Accelerating Admixture: ASTM C 494/C 494M, Type C.
f. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
g. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
h. Do not use calcium chloride as an admixture.
i. Admixtures with no standard, ASTM or other, designation may be used where permitted.

4. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.
   a. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
      1) Chloride Content: 1,000 ppm.
      2) Sulfate Content as SO_4: 3,000 ppm.
      3) Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
      4) Total Solids by Mass: Less than 50,000 ppm.

B. Concrete Mix Design:

1. General:
   a. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
   b. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
   c. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
   d. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
   e. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture, or plasticizing admixture in columns, piers, pilasters, and walls.
   f. Use water-reducing admixture or high-range, water-reducing admixture, or plasticizing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.

g. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
h. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
i. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials, aggregate packing, and self-consolidating concrete.

2. Potential Alkali-Aggregate Reactivity of Concrete:
   a. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
   b. Unless otherwise specified, or unless members are assigned to Exposure Class C0, use one of the three options below for qualifying concrete mixtures to reduce the potential of alkali-silica reaction. Option 3) shall not be used with natural pozzolans, or fly ash that has a CaO content more than 18 percent, or for aggregates with expansions greater than or equal to 0.24 percent when tested in accordance with ASTM C1293. Fly ash with an alkali content greater than 4.0 percent shall not be used in Option 2) or 3).
      1) For each aggregate used in concrete, the expansion result determined in accordance with ASTM C1293 shall not exceed 0.04 percent at 1 year.
      2) For each aggregate used in concrete, the expansion result of the aggregate and cementitious materials combination determined in accordance with ASTM C1567 shall not exceed 0.10 percent at an age of 16 days. Submit supporting data for each aggregate showing expansion in excess of 0.10 percent at 16 days when tested in accordance with ASTM C1260.
      3) Alkali content in concrete (LBA), excluding that from supplementary cementitious materials and the pozzolans and slags in blended cements, shall not exceed 4 lb/yd^3 for aggregates with expansions more than or equal to 0.04 percent and less than 0.12 percent or 3 lb/yd^3 for aggregates with expansions greater than or equal to 0.12 percent and less than 0.24 percent. Reactivity shall be determined by testing in accordance with ASTM C1293. Alkali content shall be calculated as follows:
         a) LBA = (cement content, lb/yd^3) × (equivalent alkali content of portland cement in percent/100 percent).

3. Proportions:
    a. Design mix to meet aesthetic, durability, and strength requirements.
    b. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.
4. Slump:
    a. Unless otherwise specified, and prior to submitting mix design, select a target slump at the point of delivery for concrete mixtures used for Work. Selected target slump shall not exceed 9 inches. Concrete shall not show visible signs of segregation. The target slump indicated on the submittal shall be used as the basis for acceptance during the project. Determine the slump by ASTM C143/C143M.
    b. Slump tolerance shall meet requirements of ACI 117.

C. Concrete Mixing:

1. General: In accordance with ACI 301, except as modified herein.
2. Truck Mixers:
    a. For every truck, test slump of samples taken per ASTM C94/C94M, Paragraph 12.5.1.
    b. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.03 REINFORCING STEEL

A. Deformed Steel Reinforcing Bars: ASTM A615/A615M, Grade 60. Welding of reinforcing bars is not permitted.

B. Fabrication: Follow CRSI Manual of Standard Practice.

2.04 ANCILLARY MATERIALS

A. Bonding Agent:

1. Unless otherwise specified, in accordance with the following:
    a. ASTM C881/C881M, Type V.
    b. Two-component, moisture-insensitive, 100 percent solids epoxy.
    c. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
    d. Manufacturers and Products:
        1) Master Builders Solutions, US, Shakopee, MN; MasterInject 1500.

2) Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
3) Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.
4) Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.
5) "Or-equal" Engineer approved.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
   a. Dayton Superior Corporation, Kansas City, KS; EDOCO Clean Lift Bond Breaker.
   b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.
   c. "Or-equal" Engineer approved.

C. Reinforcing Steel Accessories:

1. Plastic Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 1 Reinforcement Supports.
2. Stainless Steel Protected Wire Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Class 2 Reinforcement Supports, except legs shall be made wholly from stainless steel wire.
3. Precast Concrete Bar Supports: In compliance with ANSI/CRSI – RB 4.1 Cementitious (Precast) Reinforcement Supports.
   a. Precast concrete bar supports shall have equal or greater strength than the surrounding concrete.
   b. Precast concrete bar supports shall be four square inches minimum, in plan.
   c. Precast concrete bar supports shall have tie wires.

D. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-coated, epoxy-coated, or plastic-coated wire.

E. Premolded Joint Filler:

1. Bituminous Type: ASTM D994/D994M or ASTM D1751.
2. Sponge Rubber:
   a. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum.
   b. Manufacturer and Product:
      1) Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK515IHD.
      2) "Or-equal" Engineer approved.

F. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.
2. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
   b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
   c. Vexcon Chemical, Inc., Philadelphia, PA; Starseal 1315.
   d. Dayton Superior; Safe Cure and Seal 1315 EF.
   e. "Or-equal" Engineer approved.

G. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
   a. Master Builders Solutions, US, Shakopee, MN; MasterKure ER 50.
   b. Euclid Chemical Co., Cleveland, OH; Eucobar.
   c. "Or-equal" Engineer approved.

H. Nonshrink Grout:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
   a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   b. Temperatures of 40 degrees F, 80 degrees F, and 100 degrees F.
5. Pass fluid grout through flow cone with continuous flow 1 hour after mixing.
6. Minimum Strength of Fluid Grout:
   a. 3,500 psi at 1 day.
   b. 4,500 psi at 3 days.
   c. 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1 yard to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. Master Builders Solutions, US, Shakopee, MN; MasterFlow 928.
   b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
   c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.

d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
e. “Or-equal” Engineer approved.

I. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer’s Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer’s written recommendations.
6. Manufacturers and Products:
   a. Master Builders Solutions, US, Shakopee, MN; MasterEmaco S Series products.
   b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop Series.
   c. “Or-equal” Engineer approved.

J. Crack Repair:

1. Obtain Letter of Certification from manufacturer’s technical representative, that products selected are appropriate for the specific applications.
2. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer’s written recommendations.
3. Use part epoxy injection resin for structural crack repairs.
   a. Manufacturers:
      1) Master Builders Solutions, US Shakopee, MN; MasterInject Series.
      2) Euclid Chemical Co., Cleveland, OH.; Euco Series (#452).
      3) Sika Chemical Corp., Lyndhurst, NJ.; Sikadur Series.
      4) “Or-equal” Engineer approved.

2.05 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 FORMWORK

A. Form Construction:

1. Construct forms and provide smooth-form finish.
2. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
3. Make joints tight to prevent escape of mortar and to avoid formation of fins.
4. Brace as required to prevent distortion during concrete placement.
5. On exposed surfaces, locate form ties in uniform pattern or as shown.
6. Construct so ties remain embedded in the member with no metal within 1 inch of concrete surface when forms, inserts, and tie ends are removed.

B. Form Removal:

1. Nonsupporting forms (walls and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
   a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
   b. Curing and protection operations are maintained.
2. Remove forms with care to prevent scarring and damaging the surface.
3. Prior to form removal, provide thermal protection for concrete being placed under the requirements of cold weather concreting.

3.02 PLACING REINFORCING STEEL

A. Unless otherwise specified, in accordance with ACI 301.

B. Accessories:

1. Bar Supports in Contact with Ground: Provide precast concrete block supports.
   a. Do not use brick, broken concrete masonry units, spalls, rocks, construction debris, or similar material for supporting reinforcing steel.
2. Bar Supports in Contact with Forms: Unless otherwise noted, bar supports shall be plastic protected wire bar supports, stainless steel protected wire bar supports, or precast concrete block bar supports.
   a. Use stainless steel protected wire bar supports or precast concrete block bar supports at formed surfaces that will receive abrasive blasting, hydro-blasting, or grinding.

3. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports, and location of reinforcement remains within tolerance throughout work.

C. Splices and Laps:

1. Lap Splice Reinforcing: Refer to Structural General Notes on the Drawings for additional information.
2. Tie splices with 18-gauge annealed wire as specified in CRSI Standard.

3.03 CONCRETE PLACEMENT INTO FORMWORK

A. Inspection: Notify Engineer at least 1 work day in advance before starting to place concrete.

B. Placement into Formwork:

1. Reinforcement: Secure in position before placing concrete.
2. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs that shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use placement devices (such as, chutes, pouring spouts, and pumps) as required to prevent segregation.
5. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
6. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.

C. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Wipe clean with device that does not allow mortar to adhere to belt.
4. Cover conveyor belts and chutes.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

3.04 CONSOLIDATION AND VISUAL OBSERVATION

A. Provide at least one standby vibrator in operable condition at placement site prior to placing concrete.

3.05 COLD WEATHER PLACEMENT

A. Unless otherwise permitted, shall be in accordance with requirements of ACI 301, ACI 306.1, and as follows:

1. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
2. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.
3. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
4. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
5. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
6. Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

B. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.

C. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

D. Cure as specified.

3.06 HOT WEATHER PLACEMENT

A. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:

1. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
2. Internal concrete temperature in structure shall not exceed 158 degrees F, and maximum temperature differential between center of section and external surfaces of concrete shall not exceed 35 degrees F.
3. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
4. Cure as specified.

3.07 CONCRETE BONDING

A. Construction Joints at Existing Concrete:

1. Thoroughly clean and roughen existing concrete surfaces to roughness profile of 1/4 inch.
2. Saturate surface with water for 24 hours prior to placing new concrete.

3.08 PREMOLDED JOINT FILLER INSTALLATION

A. Sufficient in width to completely fill joint space where shown.

B. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.

C. Secure premolded joint filler in forms before concrete is placed.

3.09 FINISHING FORMED SURFACES

A. Provide surface finish 2.0 (SF-2.0) in accordance with ACI 301 and as herein specified.

B. Prepare substrate and mix, place, and cure repair material per manufacturer’s written recommendations.

C. Repair defective areas of concrete.

1. Cut edges perpendicular to surface at least 1/2-inch deep. Do not feather edges. Soak area with water for 24 hours.
2. Patch with specified repair material.
3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

3.10 FINISHING UNFORMED SURFACES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Do not dust surfaces with dry materials nor add water to surfaces.
4. Cure concrete as specified.

B. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Steel gauge block 5/16-inch thick.
4. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.

5. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

C. Exterior Slab Finish:

1. Provide broom finish unless specified otherwise.
2. Finish exposed edges with steel edging tool.

3.11 EXPOSED METAL OBJECTS

A. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.

B. Repair area of chipped-out concrete as specified for defective areas.

3.12 BLOCKOUTS AT PIPES OR OTHER PENETRATIONS

A. Where shown, install in accordance with requirements of Drawings.

3.13 PROTECTION AND CURING

A. Protect and cure concrete in accordance with requirements of ACI 301, ACI 308.1, and as follows:

1. Protect fresh concrete from direct rays of sunlight, drying winds, and wash by rain.
2. Use curing compound.
3. Cure formed surfaces with curing compound applied in accordance with manufacturer’s written instructions as soon as forms are removed and finishing is completed.
4. Remove and replace concrete damaged by freezing.
5. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.14 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer’s written instructions.

3.15 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.16 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours and for additional time as may be required before transporting to test lab.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M.
8. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

4. Test Procedure: Make slump test and check for excessive slump. Observe to see if mortar or moisture flows from slumped concrete.
5. Reject concrete if mortar or moisture separates and flows out of mix.

C. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
   a. Six extra test cylinders from last 100 cubic yards of concrete.
   b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal.

D. Slab Finish Tolerances and Slope Tolerances:

1. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
2. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

3.17 SUPPLEMENTS

A. Requirements of concrete mix designs following “End of Section,” are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4000F1S1W0C1.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4000F1S1W0C1

A. Mix Locations: Typical.

B. Exposure Categories and Classifications: F1S1W0C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.45.
2. Minimum concrete compressive strength (f'c) shall be 4,000 psi at 28 days.
   a. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	**Air Content (%)***
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is ±1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on sieved fraction passing 1-1/2-inch sieve in accordance with ASTM C231/C231M.

3. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.

2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

4. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.
   a. Limits are stated in terms of chloride ions in percent by weight of cement.
   b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A967/A967M, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   e. E488/E488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
   f. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   g. F594, Standard Specification for Stainless Steel Nuts.
5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete Anchors.
6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete Anchors.
   b. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   c. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete Anchors.
7. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete Anchors:
   a. Manufacturer’s product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
2. Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.

2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1, +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
   c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:
   a. DeWalt/Powers Fasteners, Brewster, NY; Wedge-Bolt+ (ESR-2526).
   b. DeWalt/Powers Fasteners, Brewster, NY; Vertigo+ Rod Hanger Screw Anchor (ESR-2989).
   c. DeWalt/Powers Fasteners, Brewster, NY; Snake+ Flush Mount Screw Anchor (ESR-2272).
   d. Hilti, Inc., Tulsa, OK; HUS-EZ Screw Anchor (ESR-3027).
   e. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).

D. Adhesive Anchors:

1. Threaded Rod:
   a. Diameter as shown on the Drawings.
   b. Length as required to provide minimum depth of embedment indicated and thread projection required.
   c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
   a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
   b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
   a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
   b. Store adhesive on pallets or shelving in a covered storage area.
   c. Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

d. Dispose of when:
   1) Shelf life has expired.
   2) Stored other than in accordance with manufacturer's instructions.

4. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814).
   b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-3G Epoxy Adhesive Anchors. (ESR-4057).
   c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

PART 3 EXECUTION

3.01 CONCRETE ANCHORS

A. Begin installation only after concrete to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on the Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Engineer and adhesive manufacturer:
   a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
   b. Do not install prior to concrete attaining an age of 21 days.
   c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.

d. Do not disturb anchor during recommended curing time.
e. Do not exceed maximum torque as specified in manufacturer's instructions.

3.02 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete		
Interior Dry Areas	Stainless steel anchors	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	
2. All Others		
All service uses and locations	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Iron and Steel Institute (AISI): Stainless Steel Types.
3. American National Standards Institute (ANSI).
4. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
5. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. A276, Standard Specification for Stainless Steel Bars and Shapes.
   e. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   f. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   g. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   h. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
   i. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   j. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
   k. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   l. F594, Standard Specification for Stainless Steel Nuts.
6. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.

c. Stainless Steel Fabrication.
d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.

B. Informational Submittals: Passivation method for stainless steel members.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Store fabricated items in dry area, not in direct contact with ground.

1.05 SPECIAL GUARANTEE

A. Manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Aluminum:	
Aluminum Plates	B209, Alloy y6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW

B. Bolts, Washers, and Nuts: Use stainless steel material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on the Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

2.03 SIDEWALK DOORS

A. Load Capacity: HS-10 (8-kip wheel load) with maximum deflection of 1/150th of span.

B. Component Fabrication:

1. Access Door Leaf(s): Minimum 1/4-inch aluminum diamond pattern plate.
2. Channel Frame: 1/4-inch thick extruded aluminum trough frame with continuous anchor flange around perimeter. Weld 1-1/2-inch diameter drain coupling, and drain pipe, to frame trough at front right corner, unless indicated otherwise on the Drawings.

C. Door Hardware:

1. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
2. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
3. Hold-Open Arm:
   a. Locks automatically in open position.
   b. Disengages with slight pull on vinyl grip with one hand.
   c. Door can be easily closed with one hand by pulling forward and down on vinyl grip.
4. Snap Lock:
   a. Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
   b. Threaded plug for flush outside surface with key wrench removed.

D. Aluminum: Mill finished with protective coating applied to surfaces to be in contact with concrete.

1. One coat, 10 mils Minimum Dry Film Thickness (MDFT) single-component, coal-tar pitch based Bituminous Paint.

E. Manufacturers and Products:

1. U.S.F. Fabrication, Hialeah, FL; T Series.
2. ITT Flygt Corporation, Trumbull, CT; FDRN Series.
3. Thompson Fabricating Co., Birmingham, AL; TE Series.
4. Halliday Products, Orlando, FL; WS Series.
5. “Or-equal” Engineer approved.

2.04 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

2.05 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
   a. Bostik, Middleton, MA; Neverseez.
   b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on the Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.
4. Manufacturer and Product: Monmouth Rubber and Plastics Corporation, Long Branch, NJ; Durafoam DK1111LD.

2.06 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials: Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.

2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Aluminum: Meet requirements of AWS D1.2/D1.2M.
4. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
5. Complete welding before applying finish.

D. Painting: Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, unless indicated otherwise.

E. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals.

F. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

G. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.07 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer’s recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ELECTROLYTIC PROTECTION

A. Aluminum:

1. Coat surfaces of aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals. Allow coating to dry before installation of the material.
2. Protect coated surfaces during installation.
3. Should coating become marred, prepare and touchup in accordance with paint manufacturer’s written instructions.

B. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.04 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete		
Interior Dry, Exterior and Interior Wet Areas, and Submerged and Corrosive Areas	Stainless steel headed anchor bolts	
2. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
3. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
4. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM): A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. International Code Council (ICC):
   a. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
3. National Fire Protection Association (NFPA):
   a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
   b. HAZ-01, Fire Protection Guide to Hazardous Materials.
4. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.
2. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s installation instructions.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

PART 2 PRODUCTS

2.01 SIGN TYPES

A. Fiberglass Sign (Type C):

1. Material: Three-ply laminated fiberglass, minimum 1/8-inch thick, with contrasting color core message layer between two clear weather-resistant surface layers.

2. Manufacturers:
    a. Best Sign Systems.
    b. Brady Signmark.

B. Hazardous Material Sign (Type H):

1. Conform to NFPA 704 and NFPA HAZ-01.
2. Material: Adhesive vinyl.
3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
4. Manufacturers:
    a. Brady Signmark.
    b. Emed Co., Inc.

2.02 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 SIGNS

A. General:

1. Fasten to walls or posts, or hang as scheduled.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.
3. Install facing traffic/foot traffic or for high visibility with minimum restriction of working area around walkways and equipment.
4. Install as scheduled.

B. Hazardous Material Sign:

1. Install where required by NFPA No. 704 and IFC, Chapter 27.
2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled, and on sides of stationary tanks.

3.03 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification.

1. Sign Schedule.
2. Sign Detail.

END OF SECTION

Sign Schedule

Sign									Lettering					
			Size			Mounting								
Number[1]	Sign Type[2]	Detail Reference[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
S-6	C	Type 1	20"	14"	White	Wall	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at interior hose valves
S-7	C	Type 1	20"	14"	White	Pipe Post	Bolts	3'-6"	1" min.	Helvetica	Black	DANGER Nonpotable Water Not for Drinking	1	Provide at exterior hose valves
H-1	H	Type 2	As per NFPA requirements										1	See below

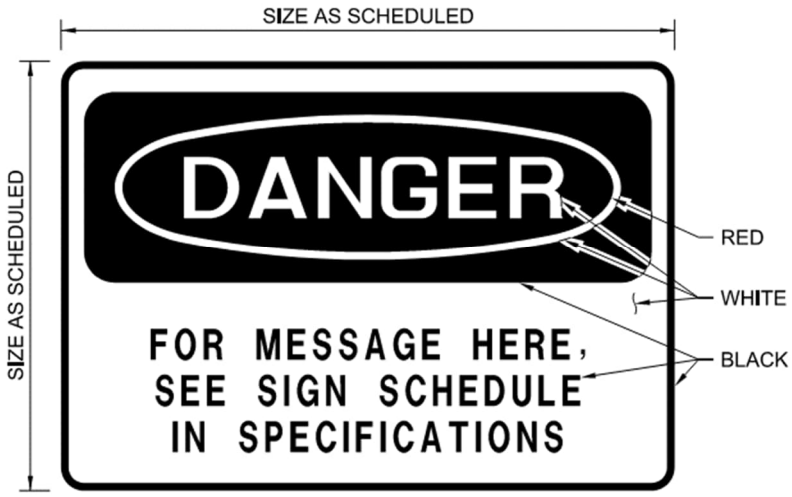
[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to Sign Types specified in this section.
[3]See following supplement sheets
[4]Verify requirements for this sign with Regulations in state where Project is located.

Hazardous Material Signs

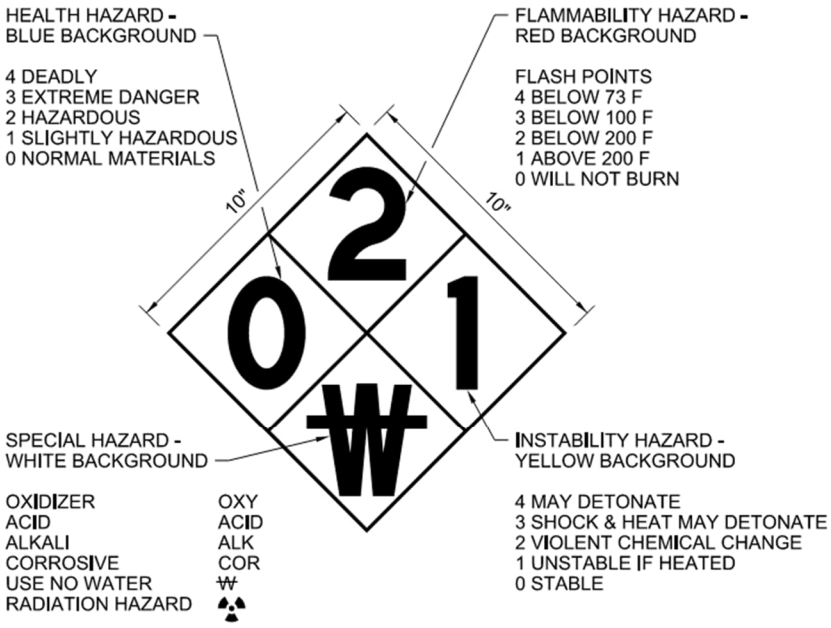
Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)	Location
H-1	Aluminum Chlorohydrate	1	0	0	0	1-EXTERIOR OF TANK 2-EXTERIOR DOOR OF ENCLOSURE

SIGN DETAIL

TYPE 1



TYPE 2



NOTES:

1. LETTER HEIGHT: 4"
   LETTER COLOR: BLACK
2. NUMBERS AND LETTERS ON ABOVE SIGNAL DETAIL ARE EXAMPLES ONLY. SEE SPECIFICATION 10 14 00 FOR REQUIREMENTS ON THIS PROJECT.

SECTION 13 34 23
FABRICATED STRUCTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Aluminum Association (AA).
2. American Architectural Manufacturers Association (AAMA): 101, and General Finishing Documents.
3. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
5. ASTM International (ASTM): E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Fire Protection Association (NFPA):
   a. 10, Standard for Portable Fire Extinguishers.
   d. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   e. 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   f. 101, Life Safety Code.
7. Steel Door Institute (SDI): 250.8 2014, Recommended Specifications for Standard Steel Doors and Frames.

1.02 SYSTEM DESCRIPTION

A. Design, furnish, and install complete FRP building package using manufacturer’s standard components. Fabricated fiberglass building shall be designed to be moved and installed as a single unit.

1. Interior Dimensions: 7 feet - 4 inches wide by 11 feet - 4 inches depth by 9 feet - 6 inches high.
2. Roof Slope: Manufacturer’s standard or as otherwise shown.
3. Include: Doors, louvers, insulation, ventilation fan, unit heater, lights, receptacles, load center, pre-wired electrical conduit and wiring, and roof accessories.

B. Design: Coordinate enclosure design with electrical equipment, chemical feed system, and water heater to be enclosed.

C. Control indoor air quality and provide electrical illumination and power.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed building system.
   b. Drawings prepared specifically for this Project:
      1) Materials and Details: Show materials, details of components (including doors, louvers, ventilation fan, unit heater, lighting, receptacles, load center and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details, including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, and openings.

      3) Signed and sealed by Professional Engineer license in the State of Georgia.
   c. Concrete anchorage recommendations including anchor layout and design loads.
   d. Painting Systems: Specifications; include paint manufacturer's name, product trade name, and preparation for shop and field coats.
2. Samples: Colors of available interior and exterior finishes.

B. Informational Submittals:

1. Structural calculations signed and sealed by Professional Engineer license in the State of Georgia. Experience records of manufacturer and installer.
2. Approval of installer by manufacturer of structure components.
3. Certification that codes and referenced standards have been met.
4. Description and details of electrical continuity and grounding methods.
5. Test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Designers: Engineer registered in state where building is to be erected.
2. Manufacturer:
   a. At least 5 years' experience in work of type required in this section.
   b. Production capacity to provide work required for this Project without delay.
3. Erector/Installer:
   a. Not less than 5 years' experience in erection of prefabricated structures similar to this Project, documented with references and contact information.
   b. Approved by manufacturer of building components.

B. Regulatory Requirements: Design building system to meet requirements of:

1. International Building Code 2018 Edition.
2. International Mechanical Code 2018 Edition.
3. International Energy Conservation Code 2015 Edition.
4. International Fire Code 2018 Edition.

REPLACED WITH CHANGE No.1

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver building components in undamaged condition to Site when ready for installation.

B. Protect products from damage and deterioration.

C. Handle products in accordance with manufacturers' instructions.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a minimum period of 5 years and as stated below after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

B. Conditions: Roofing and wall assemblies will remain weathertight for 20 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products of the following, meeting these Specifications, may be used on this Project: Tracom.

2.02 SYSTEM PERFORMANCE

A. Design Criteria shall comply with the requirements in Section 01 61 00, Common Product Requirements.

B. Structural Loading: Design structure in accordance with the Design Criteria listed on the General Structural Notes Drawing.

C. Environmental Design Conditions:

1. Temperature: Shall be able to tolerate, without compromise to the structural integrity, temperatures between negative 10 and 105 degrees F.

2.03 COMPONENTS

B. Doors: Enclosure should include a double door. Door leaf size: 36 inches by 84 inches. Exterior stainless steel single-point key locked lever handle with interior T-18-8 stainless steel touch-bar exit device (panic hardware).

C. Shell:

1. Provide weathertight structure that has straight, plumb walls with square corners.
2. Provide solid enclosure with no openings capable of allowing rodents or other small animals entry into the building.
3. Slope roof to drain, collect storm water, and convey away from building perimeter without ponding.
4. Exterior finishes: Manufacturer’s Standard.
5. Insulating value of R-21.

D. Interior:

1. Walls: Vertical, smooth surface with minimum joints or seams, painted with scrubbable paint.
2. Provide structural reinforcement in walls at all locations where equipment and piping are to be attached to the walls.

E. Heating and Ventilation: Furnish heating and ventilating systems to maintain inside temperature between 50 and 100 degrees F. Provide a 585 CFM wall mounted exhaust fan with exterior FRP hood fitted with stainless steel birdscreen and gravity damper. Provide a 3000 W wall mounted space unit heater. Provide an 18 inch by 18 inch wall louver with motorized damper for fresh air make-up interlocked to the exhaust fan. Any ventilation or heating equipment provided to maintain temperature shall be suitable from 120V or 208V operation and powered from the load center provided with the enclosure. Heating and Ventilation equipment shall be controlled thermostatically.

F. Fire Protection: Dry chemical fire extinguishers in accordance with NFPA 10.

G. Electrical Systems:

1. All electrical shall be in accordance with National Electrical Code.
2. Install products in accordance with manufacturers' instructions and recommendations.
3. Load Center: The building shall be equipped with an electrical load center to distribute power to the various components that are provided as part of the fabricated building. In addition, the load center will

integral surge protective device (SPD). Load center shall be in NEMA 4X enclosure.
4. Breaker sizes for any fan, heater or HVAC equipment provided with enclosure shall be coordinate with HVAC equipment supplied.
5. Illumination Level: At 36 inches above floor, 50 footcandles minimum from LED luminaires. Provide a minimum of two vapor tight LED fixtures. Fixture shall be enclosed and gasketed with fiberglass housing and high impact resistant acrylic diffuser. Provide light switch with weatherproof cover at door to control lights.
6. Provide two 15A, 120V GFCI duplex receptacles with while-in-use weatherproof covers for pumps with one spare outlet.
7. Receptacles, lights, fan, and heater shall be prewired to load center. Provide all internal wiring and conduit runs to the various ancillary equipment supplied with the package.
8. Ensure electrical continuity for grounding purposes between metal structure and wall panels. Provide grounding to earth for metal frame.
9. Refer to DWG 06-E-001 for additional circuit breakers required for external loads being fed by load center LP-2. As minimum, the followings additional breakers need to be provided:
   a. Four, 20A/1P EGFI breakers to power heat trace loads and safety shower.

b. Four, 20A/1P breakers for instruments, field panels, and RTU.

10. Refer to Section 26 05 01, Electrical, for electrical material requirements.

2.04 MATERIALS

A. Fiberglass Reinforced Plastic: Building shall be constructed using dual shell fiberglass reinforced plastic using a premium grade, isophthalic polyester resin. Gelcoat shall have UV inhibitors, grey cloud color with textured finish.

B. Foam Core: Insulation shall be 3-inch thick polyisocyanurate. Minimum R-21.

C. Structure shall have an internal mounting flange with neoprene rubber gasket.

D. Structure shall be equipped with removeable stainless steel lifting eyes.

E. Fiberglass: Meet requirements of Voluntary Product Standard PS-15.

F. Sealant: Single part polyurethane or silicone meeting ASTM C920, Type S, Grade NS, Class 25.

G. Doors, Frames, and Hardware: Manufacturer's standard. Doors shall have a

H. Door sweep shall have an aluminum flange with neoprene seal.

I. Finishes: Manufacturer's standard.

2.05 SOURCE QUALITY CONTROL

A. Inspections: Before shipment, inspect for complete, functional assembly.

B. Tests: Perform manufacturers' standard tests and adjustments on mechanical and electrical equipment and other moving and operating components.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Site and access to determine effect on proposed building.

3.02 PREPARATION

A. Verify Site conditions and make necessary field measurements.

B. Perform Site modifications to suit installation of prefabricated building.

3.03 ERECTION

A. Erect structure in accordance with manufacturer's instructions. Securely anchor to concrete foundation.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of permanent, stable structure.

C. Install materials following manufacturers' instructions and recommendations.

3.04 FIELD FINISHING

A. Do not paint electrical equipment.

3.05 HEATING AND VENTILATING

A. Install equipment and components following manufacturer's instructions and local authorities having jurisdiction.

B. Meet requirements of NFPA 90A and NFPA 90B.

REPLACED WITH CHANGE No.1

A. Electrical components shall be factory installed and pre-wired by the manufacturer. All components added by the Contractor shall be installed in accordance with Division 26, Electrical of these Specifications.

B. In accordance with requirements of NFPA 70.

C. Install products in accordance with manufacturers' instructions and recommendations.

D. Provide grounding for building.

3.07 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on moving and operating components.

B. Performance Tests: Test HVAC system.

C. Electrical Continuity: Test continuity of completed metal structure and installed equipment to ground.

3.08 MANUFACTURER'S SERVICES

A. Provide manufacturers' representatives at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

3.09 CLEANING/ADJUSTING

A. Adjust moving and operating components for smooth operation.

B. Thoroughly clean interior and exterior of building and leave weathertight and ready for use.

END OF SECTION

SECTION 13 34 23
FABRICATED STRUCTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Aluminum Association (AA).
2. American Architectural Manufacturers Association (AAMA): 101, and General Finishing Documents.
3. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
5. ASTM International (ASTM): E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Fire Protection Association (NFPA):
   a. 10, Standard for Portable Fire Extinguishers.
   b. 13, Standard for the Installation of Sprinkler Systems.
   c. 70, National Electrical Code.
   d. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   e. 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   f. 101, Life Safety Code.
7. Steel Door Institute (SDI): 250.8 2014, Recommended Specifications for Standard Steel Doors and Frames.

1.02 SYSTEM DESCRIPTION

A. Design, furnish, and install complete FRP building package using manufacturer’s standard components. Fabricated fiberglass building shall be designed to be moved and installed as a single unit.

1. Interior Dimensions: 7 feet - 4 inches wide by 11 feet - 4 inches depth by 9 feet - 6 inches high.
2. Roof Slope: Manufacturer’s standard or as otherwise shown.
3. Include: Doors, louvers, insulation, ventilation fan, unit heater, lights, receptacles, ~~load center, pre-wired electrical conduit and wiring,~~ and roof accessories.

B. Design: Coordinate enclosure design with electrical equipment, chemical feed system, and water heater to be enclosed.

C. Control indoor air quality ~~and provide electrical illumination and power~~.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed building system.
   b. Drawings prepared specifically for this Project:
      1) Materials and Details: Show materials, details of components (including doors, louvers, ventilation fan, unit heater, lighting, receptacles, load center and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details, including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, and openings.
      2) Manufacturer's Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.
      3) Signed and sealed by Professional Engineer license in the State of Georgia.
   c. Concrete anchorage recommendations including anchor layout and design loads.
   d. Painting Systems: Specifications; include paint manufacturer's name, product trade name, and preparation for shop and field coats.
2. Samples: Colors of available interior and exterior finishes.

B. Informational Submittals:

1. Structural calculations signed and sealed by Professional Engineer license in the State of Georgia. Experience records of manufacturer and installer.
2. Approval of installer by manufacturer of structure components.
3. Certification that codes and referenced standards have been met.
4. Description and details of electrical continuity and grounding methods.
5. Test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Designers: Engineer registered in state where building is to be erected.
2. Manufacturer:
   a. At least 5 years' experience in work of type required in this section.
   b. Production capacity to provide work required for this Project without delay.
3. Erector/Installer:
   a. Not less than 5 years' experience in erection of prefabricated structures similar to this Project, documented with references and contact information.
   b. Approved by manufacturer of building components.

B. Regulatory Requirements: Design building system to meet requirements of:

1. International Building Code 2018 Edition.
2. International Mechanical Code 2018 Edition.
3. International Energy Conservation Code 2015 Edition.
4. International Fire Code 2018 Edition.
5. National Electrical Code 2020 Edition.
6. State of Georgia Amendments.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver building components in undamaged condition to Site when ready for installation.

B. Protect products from damage and deterioration.

C. Handle products in accordance with manufacturers' instructions.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a minimum period of 5 years and as stated below after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

B. Conditions: Roofing and wall assemblies will remain weathertight for 20 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products of the following, meeting these Specifications, may be used on this Project: Tracom.

2.02 SYSTEM PERFORMANCE

A. Design Criteria shall comply with the requirements in Section 01 61 00, Common Product Requirements.

B. Structural Loading: Design structure in accordance with the Design Criteria listed on the General Structural Notes Drawing.

C. Environmental Design Conditions:

1. Temperature: Shall be able to tolerate, without compromise to the structural integrity, temperatures between negative 10 and 105 degrees F.

2.03 COMPONENTS

A. Substructure: Cast-in-place concrete foundation provided by others.

B. Doors: Enclosure should include a double door. Door leaf size: 36 inches by 84 inches. Exterior stainless steel single-point key locked lever handle with interior T-18-8 stainless steel touch-bar exit device (panic hardware).

C. Shell:

1. Provide weathertight structure that has straight, plumb walls with square corners.
2. Provide solid enclosure with no openings capable of allowing rodents or other small animals entry into the building.
3. Slope roof to drain, collect storm water, and convey away from building perimeter without ponding.
4. Exterior finishes: Manufacturer’s Standard.
5. Insulating value of R-21.

D. Interior:

1. Walls: Vertical, smooth surface with minimum joints or seams, painted with scrubbable paint.
2. Provide structural reinforcement in walls at all locations where equipment, conduit, and piping are to be attached to the walls.

E. Heating and Ventilation: Furnish heating and ventilating systems to maintain inside temperature between 50 and 100 degrees F. Provide a 585 CFM wall mounted exhaust fan with exterior FRP hood fitted with stainless steel birdscreen and gravity damper. Provide a 3000 W wall mounted space unit heater. Provide an 18 inch by 18 inch wall louver with ~~motorized~~ damper for fresh air make-up ~~interlocked to the exhaust fan~~. Any ventilation or heating equipment provided to maintain temperature shall be suitable from 120V or 208V operation and powered from the ~~load center provided with the enclosure~~load center provided by others. Heating and Ventilation equipment shall be controlled thermostatically.

F. Fire Protection: Dry chemical fire extinguishers in accordance with NFPA 10.

G. Electrical Systems:

1. All electrical shall be in accordance with National Electrical Code.
2. Install products in accordance with manufacturers' instructions and recommendations.
3. Load Center: A step-down transformer and 120/208V panelboard will be provided by others ~~The building shall be equipped with an electrical load center~~ to distribute power to the various components that are provided as part of the fabricated building and identified in the Drawings. ~~In addition, the load center will provide breakers for the chemical feed system as indicated in the load center panel schedule. The load center shall be 120/208V, three-phase, 12-poles, 100A load center with a 60A main circuit breaker with integral surge protective device (SPD). Load center shall be in NEMA 4X enclosure.~~ Refer to Drawing G 06-E-001 for load center LP-2 panel schedule.
4. ~~Breaker sizes for any fan, heater or HVAC equipment provided with enclosure shall be coordinate with HVAC equipment supplied.~~
4. Provide heating and ventilation equipment as required including fan, heater, or HVAC equipment.
5. Illumination Level: At 36 inches above floor, 50 footcandles minimum from LED luminaires. Provide a minimum of two vapor tight LED fixtures. Fixture shall be enclosed and gasketed with fiberglass housing and high impact resistant acrylic diffuser. Provide light switch with weatherproof cover at door to control lights.
6. Provide two 15A, 120V GFCI duplex receptacles with while-in-use weatherproof covers for pumps with one spare outlet. Coordinate location with approved equipment layout.
7. Receptacles, lights, fan, and heater shall be factory installed ~~shall be prewired~~ and will be wired to load center by others. ~~Provide all internal wiring and conduit runs to the various ancillary equipment supplied with the package.~~

8. Ensure electrical continuity for grounding purposes between metal structure and wall panels. Provide grounding to earth for metal frame.
~~9. Refer to DWG 06-E-001 for additional circuit breakers required for external loads being fed by load center LP-2. As minimum, the followings additional breakers need to be provided:~~
~~a. Four, 20A/1P EGFI breakers to power heat trace loads and safety shower.~~
~~b. Four, 20A/1P breakers for instruments, field panels, and RTU.~~
~~10.~~9. Refer to Section 26 05 01, Electrical, for electrical material requirements.

2.04 MATERIALS

A. Fiberglass Reinforced Plastic: Building shall be constructed using dual shell fiberglass reinforced plastic using a premium grade, isophthalic polyester resin. Gelcoat shall have UV inhibitors, grey cloud color with textured finish.

B. Foam Core: Insulation shall be 3-inch thick polyisocyanurate. Minimum R-21.

C. Structure shall have an internal mounting flange with neoprene rubber gasket.

D. Structure shall be equipped with removeable stainless steel lifting eyes.

E. Fiberglass: Meet requirements of Voluntary Product Standard PS-15.

F. Sealant: Single part polyurethane or silicone meeting ASTM C920, Type S, Grade NS, Class 25.

G. Doors, Frames, and Hardware: Manufacturer’s standard. Doors shall have a double, 36-inch by 84-inch doors constructed of FRP. Hinges shall be a Type 304 stainless steel strap hinge. Door latch shall be lockable, Type 316 stainless steel.

H. Door sweep shall have an aluminum flange with neoprene seal.

I. Finishes: Manufacturer’s standard.

2.05 SOURCE QUALITY CONTROL

A. Inspections: Before shipment, inspect for complete, functional assembly.

B. Tests: Perform manufacturers’ standard tests and adjustments on mechanical and electrical equipment and other moving and operating components.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Site and access to determine effect on proposed building.

3.02 PREPARATION

A. Verify Site conditions and make necessary field measurements.

B. Perform Site modifications to suit installation of prefabricated building.

3.03 ERECTION

A. Erect structure in accordance with manufacturer's instructions. Securely anchor to concrete foundation.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of permanent, stable structure.

C. Install materials following manufacturers' instructions and recommendations.

3.04 FIELD FINISHING

A. Do not paint electrical equipment.

3.05 HEATING AND VENTILATING

A. Install equipment and components following manufacturer's instructions and local authorities having jurisdiction.

B. Meet requirements of NFPA 90A and NFPA 90B.

C. Adjust for proper operation and control.

3.06 ELECTRICAL SYSTEMS

A. Electrical components shall be factory installed ~~and pre-wired by the manufacturer~~. All components added by the Contractor shall be installed in accordance with Division 26, Electrical of these Specifications.

B. In accordance with requirements of NFPA 70.

C. Install products in accordance with manufacturers' instructions and recommendations.

D. Provide grounding for building.

3.07 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on moving and operating components.

B. Performance Tests: Test HVAC system.

C. Electrical Continuity: Test continuity of completed metal structure and installed equipment to ground.

3.08 MANUFACTURER'S SERVICES

A. Provide manufacturers' representatives at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of Owner's personnel for specified component, subsystem, equipment, or system.

3.09 CLEANING/ADJUSTING

A. Adjust moving and operating components for smooth operation.

B. Thoroughly clean interior and exterior of building and leave weathertight and ready for use.

END OF SECTION

SECTION 22 07 00
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   c. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
3. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.02 SUBMITTALS

A. Action Submittals: Product description, include list of materials, thickness for each service scheduled, and locations.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Manufacturer’s installation instructions.

1.03 QUALITY ASSURANCE

A. Provide standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Deliver insulation, jackets, cements, adhesives and coatings with a manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation Packages and Containers: Mark "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Provide noncombustible insulation, adhesives, vapor barrier materials and other accessories, except as specified herein.
2. Use no fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration as a result of effects of moisture or high humidity are not acceptable.
4. Fire Hazard Rating for Materials including Facings, Mastics, and Adhesives: Not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
5. Materials exempt from fire-resistant rating:
   a. Nylon anchors.
   b. Treated wood inserts.
6. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
   a. Polyurethane insulation.
   b. PVC casing.
   c. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Flexible, closed cell elastomeric.
2. Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
3. Water Vapor Transmission: 0.1 perm-inch, or less.
4. Manufacturers and Products:
   a. Armacell; AP Armaflex.
   b. Nomaco; K-Flex LS.

2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 150 degrees F.
2. Manufacturers and Products:
   a. Johns Manville; Zeston.
   b. Ceel-Co; 550.

B. Type F2—Paint:

1. Acrylic latex paint, white, and suitable for outdoor use.
2. Manufacturer and Product: Armstrong; WB Armaflex finish.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.
2. Moisture Barrier: Provide factory-applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one- or two-piece covers, which includes elbows, tee/valves, endcaps, mechanical line couplings, and specialty fittings.
4. Manufacturer and Product: RPR Products; INSUL-MATE.

PART 3 EXECUTION

3.01 INSTALLATION OF INSULATION

A. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean, finish painted, and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Maintain integrity of vapor barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

L. Insulate valve bodies, flanges, and pipe couplings.

M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

N. Do not insulate flexible pipe couplings and expansion joints.

O. Do not allow insulation to cover nameplates or code inspection stamps.

P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

Q. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

R. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

S. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

T. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

U. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

3.02 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal exterior joints to make watertight.

3.03 INSULATION APPLICATIONS

A. Potable Cold Water:

1. Type P3, elastomeric.
2. 1-inch thickness for all pipe sizes.

B. Potable Hot and Tepid Water:

1. Type P3, elastomeric.
2. 1-inch thickness for all pipe sizes.

C. Pipe Hangers:

1. Type P3, Elastomeric: Rigid insulation section with 9-inch long, 16-gauge galvanized steel saddle.

3.04 INSULATION FINISH APPLICATIONS

A. Piping Insulation (Concealed Areas): Factory finish.

B. Piping Insulation (Exposed to View, Indoors): Type F1, PVC.

C. Piping Insulation (Outdoors): Type F3, aluminum.

D. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.05 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

SECTION 22 10 01
PLUMBING PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA):
   a. B109.1, Diaphragm Type Gas Displacement Meters (under 500 Cubic Feet Per Hour Capacity).
   b. B109.2, Diaphragm Type Gas Displacement Meters (500 Cubic Feet Per Hour Capacity and Over).
2. American National Standards Institute (ANSI).
3. American Public Works Association (APWA): Uniform Color Code.
4. American Society of Sanitary Engineering (ASSE):
   a. 1010, Performance Requirements for Water Hammer Arresters.
   b. 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
   c. 1070, Performance Requirements for Water Temperature Limiting Devices.
5. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   d. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A179/A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes.
   g. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A197/A197M, Standard Specification for Cupola Malleable Iron.

k. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
m. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
n. A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
o. A536, Standard Specification for Ductile Iron Castings.
p. A563, Standard Specification for Carbon and Alloy Steel Nuts.
q. A861, Standard Specification for High-Silicon Iron Pipe and Fittings.
r. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
s. B32, Standard Specification for Solder Metal.
t. B61, Standard Specification for Steam or Valve Bronze Castings.
u. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
v. B75/B75M, Standard Specification for Seamless Copper Tube.
w. B88, Standard Specification for Seamless Copper Water Tube.
x. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
y. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
z. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
aa. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
bb. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
cc. B306, Standard Specification for Copper Drainage Tube (DWV).
dd. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
ee. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
ff. C1460, Standard Specification for Shielded Transition Couplings for use with Dissimilar DWV Pipe and Fittings Above Ground.
gg. C1540, Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
hh. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ii. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

jj. D2000, Standard Classification System for Rubber Products in Automotive Applications.
kk. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
ll. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
mm. D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
nn. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
oo. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
pp. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
qq. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
rr. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ss. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
tt. E438, Standard Specification for Glasses in Laboratory Apparatus.
uu. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
vv. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ww. F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
xx. F1924, Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing.
yy. F1973, Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
e. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
f. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied.
g. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
h. C606, Grooved and Shouldered Joints.
i. C651, Disinfecting Water Mains.

7. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Strom Drain, Waste, and Vent Piping Applications.
8. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
9. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arresters Standard.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Building Service Piping: ASME B31.9, as applicable.
2. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code. Local plumbing code.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets.
2. Shop Drawings:
   a. Show Contractor recommended changes in location of fixtures or equipment.
   b. Anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
3. Isometric riser diagrams.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the work.
3. Complete list of products proposed for installation.
4. Test records produced during testing.
5. For Polyethylene (PE) Pipe:
   a. Certificates of qualification for persons to be fusing PE pipe.
   b. Experience and training record of persons to be fusing PE pipe.
   c. Testing Plan:
      1) Submit at least 15 days prior to testing; include following as a minimum:
         a) Testing dates.
         b) Piping systems and section(s) to be tested.
         c) Method of isolation.
         d) Method of conveying water from source to system being tested.
   d. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
   e. Test report documentation.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. Piping Schedule: Refer to Section 40 27 00, Process Piping—General. Article Supplements.

B. Piping Material: Refer to Piping Data Sheet(s), Article Supplements and Section 40 27 00, Process Piping—General.

2.03 HOSE VALVES AND HYDRANTS

A. HV-1, Hose Valve:

1. Cast bronze globe valve, 1-inch size, with NPT screwed ends, union bonnet, rising stem, Teflon disc, hand wheel, and NPT by NST hose thread adapter outlet connection.
2. Rated 150-pound service water pressure, 300-pound WOG.
3. Manufacturers and Products:
   a. Nibco; Catalog No. T-235-Y, Angle No. T-335-Y.
   b. Crane Co.; Catalog No. 7TF, Angle No. 17TF.

B. YH-1, Sanitary Yard Hydrants (Freeze-proof):

1. Freestanding freeze-proof sanitary yard hydrant with automatic draining, integral ASSE 1050 double check backflow preventer, diverter spout, and drainage reservoir below frost line, 3/4-inch hose connection, 1-inch inlet connection.
2. The entire working portion of the hydrant shall be removable without excavation.
3. Bury Depth: 3 feet.
4. Manufacturer and Product: ZURN; Z1396 or equal.

2.04 PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Wall Brackets:

1. Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).
   a. Anvil; Figure 199, 3,000-pound rating.
   b. B-Line; Figure B3067, 3,000-pound rating.
2. One-Hole Clamp: Anvil; Figure 126, sizes 3/8 inch through 4 inches.
3. Channel Type:
   a. Unistrut.
   b. Anvil; Power-Strut.
   c. B-Line; Strut System.
   d. Aickinstrut (FRP).

C. Channel Type Support Systems:

1. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, 1-1/2-inch wide minimum FRP.
2. Members and Connections: Design for all loads with safety factor of 5.

3. Manufacturers and Products:
    a. B-Line; Strut System.
    b. Unistrut.
    c. Anvil; Power-Strut.
    d. Aickinstrut (FRP System).

D. Galvanize hangers, rods, clamps, protective shields, and hanger accessories.

E. Trapeze Hangers:

1. Assembly consisting of structure attachments with rod size dependent upon total weight supported, and spacing of assemblies determined by minimum pipe size included in group supported.
2. Trapeze Horizontal: Structural angle or channel section of sufficient size to prevent measurable sag between rods.
3. Manufacturers and Products:
    a. Unistrut.
    b. B-Line; Strut System.
    c. Anvil; Power-Strut.
    d. Aickinstrut (FRP System).

2.05 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

2.06 VALVES

A. General:

1. Furnish complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches.
2. Renewable Parts Including Discs, Packing, and Seats: Types as recommended by valve manufacturer for intended service.
3. Units shall have name of manufacturer and size of valve cast on body or bonnet or shown on a permanently attached plate in raised letters.

B. Design Features:

1. Brass and bronze components, including appurtenances in contact with water.
2. Alloys containing less than 16 percent zinc and 2 percent aluminum.
3. Alloys are of the following ASTM designations:
    a. B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.

b. Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Engineer.

4. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.

C. Valve Operators:

1. Open by turning counterclockwise.
2. Worm and Gear Operators On Manually Operated Valves: Totally enclosed design, proportioned as to permit operation of valve under full operating head with maximum pull of 40 pounds on handwheel or crank.
3. Self-locking type to prevent the disc or plug from creeping.
4. Self-Locking Worm Gears:
   a. One-piece design of gear bronze material, accurately machine cut.
   b. Worm: Hardened alloy steel, with thread ground and polished.
   c. Reduction gearing shall run in a proper lubricant.
5. Galvanize handwheels.

D. Ball Valves:

1. 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece body type, bronze body and end pieces, hard-chrome plated bronze or brass ball, full bore port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip.
   b. Rated 6-pound WOG, 150-psi SWP.
   c. Manufacturers and Products:
      1) Threaded Ends:
         a) Milwaukee; BA-300.
         b) Nibco; T-595-Y.
         c) Conbraco Apollo; 82-100.
      2) Soldered Ends:
         a) Milwaukee; BA-350.
         b) Nibco; S-595-Y.
         c) Conbraco Apollo; 82-200.
2. Thermoplastic Ball Valves 2 Inches and Smaller for Water Service:
   a. Rated 150 psi at 105 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride (PVC) body, ball, and stem.
   b. End entry, double union design, with replaceable Teflon seats and Viton or Teflon O-ring stem seals.
   c. Furnish with hand lever operator.
   d. Single union ball valves with flanged ends drilled to 150-pound ANSI Standard are acceptable.
   e. Manufacturers:
      1) Asahi/America.
      2) R&G Sloane Manufacturing Co., Inc.

E. Globe Valves:

1. 3 Inches and Smaller:
   a. Bronze body, replaceable composition disc, screwed ends, union bonnet, inside screw rising stem, and TFE disc.
   b. Rated 150-pound SWP, 300-pound WOG.
   c. Manufacturers and Products:
      1) Crane; No. 7TF.
      2) Nibco; No. T-235-Y.

F. Gauge Cock Valves 1/8 Inch to 3/8 Inch:

1. Bronze body, hexagon male and female ends, and tee head.
2. Rated for 125-pound SWP.
3. Manufacturers and Product:
   a. Ernst Gage Co.
   b. Lunkenheimer.

G. Manual Air Vent Valves:

1. With coin-operated air vent.
2. Manufacturers and Products:
   a. Bell & Gossett; No. 4V.
   b. Dole; No. 9.

H. Thermostatic Mixing Valve Assembly:

1. Function: Provide tempered water at 3 gpm to 50 gpm.
2. Components:
   a. High flow mixing valve for 15 gpm to 50 gpm.
   b. Low flow mixing valve for 3 gpm to 7 gpm.
   c. Pressure reducing valve.
   d. Pressure gauge.
   e. Isolation valve.
   f. Thermometer.
   g. Pipe fittings.
   h. Heavy-gauge steel cabinet with access door and manufacturer’s standard baked enamel finish.
3. Inlets: One each, 3/4-inch NPT, cold and hot water.
4. Outlets: 1-1/4-inch NPT.
5. Self-contained; no electrical requirements.
6. Performance: With 140 degrees F hot inlet and 60 degrees F cold inlet, deliver 100 degrees F at inlet pressures between 30 psig and 100 psig. Set outlet at 95 degrees F.

7. Manufacturers and Products:
    a. Powers Process Controls; Series 430/420 Hydroguard.
    b. Leonard; Model TM 850 LF.

2.07 MISCELLANEOUS PIPING SPECIALTIES

A. Strainers for Water Service:

1. Iron body, Y-pattern, 125-pound rated, with screwed bronze or bolted iron cap.
2. Screen: Heavy-gauge stainless steel or monel, 30 mesh.
3. Manufacturers and Products:
    a. Crane; No. 988-1/2.
    b. Mueller; No. 758.

B. Vacuum Breakers 2 Inches and Smaller:

1. Angle type, as required.
2. Manufacturers:
    a. Febco.
    b. Watts.

C. Water Hammer Arresters:

1. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.
2. Manufacturers and Products:
    a. Sioux Chief Mfg. Co., Inc.; Series 650 and 660.
    b. Precision Plumbing Products, Inc.

D. Water Hose:

1. Furnish 2 50-foot length(s) of 3/4-inch, EPDM black cover and EPDM tube, reinforced with two textile braids. Furnish each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
    a. Goodyear.
    b. Boston.

E. Sleeves:

1. Manufacturers and Products:
    a. J. R. Smith; Figure 1720.
    b. Josam; No. 26400.

F. Insulating Dielectric Unions and Flanges:

1. Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.
2. Unions 2 Inches and Smaller: Screwed or solder-joint type.
3. Unions 2-1/2 Inches and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.
4. Manufacturers:
   a. Epco Sales, Inc., Cleveland, OH.
   b. Capitol Insulation Unions.

G. Pipe Joint Sealer: Compound insoluble in water or Teflon tape; approved by NFS for use in potable water.

H. Rubber Gaskets: ASTM C564.

2.08 MEASURING DEVICES

A. Thermometers:

1. Adjustable angle, organic spirit type, blue in color, with 9-inch case and scale range in degrees F, as shown.
2. Furnish with 3-1/2-inch stem length and separable NPT brass thermowell.
3. Manufacturers and Product:
   a. Trerice Co.; Model A005.
   b. Weksler.

B. Pressure Gauges:

1. Construction: 3-1/2-inch gauge size, 0 kPa to 690 kPa, 0 psi to 160 psi range, steel case, glass crystal, brass movement, and 1/4-inch NPT lower connection.
2. Furnish with 1/4-inch brass gauge cock.
3. Manufacturers and Products:
   a. Ashcroft; Type 1008.
   b. Marsh; J80.
   c. Marshalltown.

PART 3 EXECUTION

3.01 GENERAL

A. Install plumbing systems to meet applicable plumbing code.

B. Field Obstructions:

1. Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.
2. Do not modify structural components, unless approved by Engineer.

C. Sleeves:

1. Pipe sizes shown are nominal sizes, unless shown or specified otherwise.
2. Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.
3. Provide pipes passing through finished walls with chrome-plated canopy flanges.
4. Dry pack sleeves in existing work in-place and provide finished appearance.
5. Pack holes left by removal of existing piping with grout and finish to match adjacent surface.

D. Provide unions in piping systems at connections to equipment.

E. Provide shielded transition couplings, insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection.

F. Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent with copper tubing to nearest drain.

G. Provide isolation valves and strainers at pressure regulators.

H. Trench Excavation and Backfill: As specified in Section 31 23 16, Excavation and Section 31 23 23.15, Trench Backfill**.**

3.02 INSTALLATION

A. Steel Pipe:

1. Ream, clean, and remove burrs and mill scale from piping before making up.
2. Seal joints with pipe joint sealer or Teflon tape.

B. Copper Tubing:

1. Cut tubing square and remove burrs.
2. Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.

3. Prevent annealing of fittings and hard-drawn tubing when making connections.
4. Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

C. Rigid PVC or CPVC:

1. Cut, make up, and install in accordance with pipe manufacturer's recommendations.
2. Ream, clean, and remove burrs from cut ends before joining pipe.
3. Lay in trench by snaking pipe from one side to other.
4. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and final use.
5. Do not lay pipe when temperature is below 40 degrees F or above 90 degrees F when exposed to direct sunlight.
6. Shield ends to be joined from direct sunlight prior to and during laying operation.
7. Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.

D. Water System Balancing: Provide a qualified registered engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

E. Water Hammer Arresters:

1. Install in piping systems where shown on the Drawings and adjacent to pieces of equipment where quick closing valves are installed.
2. Install at all emergency safety showers and eyewashes.
3. Size and install in accordance with PDI-WH201.
4. Shock arresters to have access panels or to be otherwise accessible.

F. Valves: Install in accordance with manufacturer's recommendations.

G. Miscellaneous Piping Specialties: Install in accordance with manufacturer's recommendations.

H. Measuring Devices: Install in accordance with manufacturer's recommendations.

3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

A. Installation:

1. Set piping above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.

3. Slope drain lines at minimum 2 percent slope, unless otherwise noted. Vent lines shall be installed level or sloped, with no low spots.
4. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
5. Extend vents minimum 1 foot above roof.
6. Provide cleanouts where shown and where required by code.

3.04 WATER SUPPLY PIPING

A. Water supply piping includes potable **(**W1), hot water (HW) tempered water (TW) systems and nonpotable W2 systems.

B. Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer's recommended flow.

C. Do not run water piping through electrical rooms, stairwells, or immediately over or within a 3-foot horizontal clearance of electrical panels, motor starters, or environmental control panels.

D. Provide exterior water piping with minimum 3 feet of cover or install below frost line, whichever is greater.

E. Hose Valves and Hydrants: Attach handle with setscrew and provide manufacturer's recommended gravel fill around drain hole of post hydrants.

F. Provide valve operators with position indicators, where indicated, to show position of valve disc or plug.

G. Provide bypass with globe valve for emergency throttling around each reducing valve.

H. Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.

I. Vacuum Breakers 2 Inches and Smaller: Install minimum 6 inches above flood line of equipment they serve.

J. Provide manual air vents at high points in domestic hot water system.

3.05 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

3.06 HANGERS AND SUPPORTS

A. In accordance with Section 40 05 15, Piping Support Systems.

B. Install pre-engineered support equipment in accordance with manufacturer's recommendations.

C. Hanger Rod Sizing and Spacing for:

1. Steel Pipe:

Pipe Size	Max. Hanger Spacing (feet)	Min. Rod Size (inches)
1 inch and smaller	6	1/4
1-1/4 through 2-1/2 inches	8	1/4
3 and 4 inches	10	3/8
6 inches	12	3/8
8 inches	12	1/2

2. Copper Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: 2 feet less per size than for steel pipe, except pipe 1-1/4 inches and smaller shall be supported every 6 feet.
3. Cast Iron Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: Locate hanger rods at each pipe joint and change of direction, 10-foot maximum spacing.
4. Plastic Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: As recommended by manufacturer and required by applicable plumbing code for flow and temperature in pipe.
   c. No metal portion of hanger shall contact pipe directly.

D. Attach Support Rods For Horizontal Piping:

1. To steel beams with I-clamps.
2. To concrete with inserts or with flanges fastened with flush shells.
3. To wood with thickness of 2-1/2 inches or more with bolts or angle clips.

E. Vertical Piping:

1. Support by channel type support system and pipe clamps on 10-foot maximum centers.
2. Copper and Plastic Piping: Isolate from channels and pipe clamps with pipe isolators.

F. Insulated Piping: Furnish galvanized protection shield and oversized hangers under insulated piping.

3.07 INSTALLATION—CONCRETE ENCASED

A. Where horizontal piping is encased in concrete such as a floor or equipment slab, rigidly mount pipe to rebar and subbase to prevent lateral movement, sagging, and uplifting during concrete installation and finishing. Provide at least two temporary strut supports wired to rebar and supported from the engineered fill or subbase below for each section of pipe.

B. Where construction joints occur, or piping leaves concrete encasements at buildings, utility trenches, vaults, slabs and other structures, provide elastomeric foam insulation wrap around the pipe at the transition point.

1. Minimum Wrap: five pipe diameters of 1/2-inch thick insulation on each side of the transition.

C. Provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 INTERIM CLEANING

A. As specified in Section 40 27 00, Process Piping—General.

B. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

C. Examine piping to assure removal of foreign objects prior to assembly.

D. Conventional commercial cleaning methods of cleaning are acceptable if method and cleaning material does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.09 TESTING

A. As specified in Section 40 80 01, Process Piping Leakage Testing.

B. General:

1. Conduct pressure and leakage tests on newly installed pipelines.
2. Provide necessary equipment and material, and make taps in pipe, as required.
3. Engineer will monitor tests. Provide 24-hour advance notice of start of testing.
4. Test Pressures: As specified herein and in Piping Schedule.
5. Test Records: Make records of each piping system installation during test to document the following:
   a. Date of test.

b. Description and identification of piping tested.
c. Test fluid.
d. Test pressure.
e. Remarks, including:
   1) Leaks (type, location).
   2) Repairs made on leaks.
f. Certification by Contractor and signed acknowledgment by Engineer that tests have been satisfactorily completed.

C. Testing New Pipe Connected to Existing Pipe: Isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.

D. Preparation and Execution:

1. Buried Pressure Piping:
   a. An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by Engineer.
   b. Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.
   c. Conduct final hydrostatic acceptance tests after trench has been completely backfilled.
2. Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

E. Hydrostatic Leak Tests:

1. Equipment: Provide the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

2. Procedure:
   a. Use water as the hydrostatic test fluid.
   b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.
   c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.
   d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
   e. Test piping systems at test pressure specified in Piping Schedule.

f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
g. Examine joints and connections for leakage.
h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
i. Correct visible leakage and retest to satisfaction of Engineer.

3. Buried Water Lines:
   a. A limited amount of leakage is permissible according to formula specified.
   b. Conduct hydrostatic testing as follows:
      1) Pipe with Concrete Thrust Blocking: Do not make pressure test until a minimum of 5 days after thrust blocking is installed.
      2) If high-early strength cement is used for thrust blocking, time may be reduced to 2 days.
   c. Cement-Lined Piping: Slowly fill test section with water and allow to stand for 24 hours under slight pressure to allow cement lining to absorb water.
   d. Expel air from piping system prior to testing.
   e. Apply and maintain specified test pressure with hydraulic force pump.
   f. Valve off the piping system when test pressure is reached.
   g. Conduct pressure test for 2 hours, reopening isolation valve only as necessary to restore test pressure.
   h. Accurately measure amount of water required to maintain test pressure by placing pump suction in a barrel or similar device, or by metering.
   i. The measurement represents leakage, defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.
   j. Determine maximum allowable leakage in gallons per hour from the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

k. Correct leakage greater than the allowable determined under this formula, and retest to satisfaction of Engineer.

4. Test Pressure for Water: 1-1/2 times system pressure.
5. Gravity Sewers and Drains:
   a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
   b. Repair leaks and retest system until no further leakage is evident.

F. Pneumatic Leak Tests:

1. Perform on compressed air, natural gas, and vacuum piping.
2. Equipment: Provide the following:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure
1	Calibrated test gauge

3. Procedure:
   a. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.
   b. Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.
   c. Test piping system at test pressure specified in Piping Schedule.
   d. Protect test personnel Owner's operating personnel from hazards associated with air testing.
   e. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.
   f. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
   g. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.
   h. Examine joints and connections for leakage with soap bubbles.
   i. Correct visible leaks and retest.
   j. Gradually increase pressure in system to not more than one-half of test pressure.
   k. Thereafter increase pressure in steps of approximately 1/10 of maximum test pressure until required test pressure is reached.
   l. Maintain pneumatic test pressure continuously for minimum 10 minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.

m. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.
n. Correct visible leakage and retest to satisfaction of Engineer.
o. Following pneumatic testing, thoroughly purge lines that are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in system during filling process.

3.10 CLEANING AND DISINFECTION

A. Prior to final acceptance, following assembly and testing, flush pipelines with water, except for plant process air lines and instrument air lines, and remove accumulated construction debris and other foreign matter.

B. Minimum Flushing Velocity: 2.5 feet per second.

C. Insert cone strainers in the connections to attached equipment and leave until cleaning has been accomplished.

D. Remove accumulated debris through drains 2 inches and larger or by dropping spools and valves.

E. Immediately after draining flushed lines, dry piping with compressed air.

F. Use compressed air to remove loose debris from plant process air and instrument air piping.

G. Disinfect potable water pipelines before placing in service:

1. Meet the requirements of AWWA C651, unless otherwise specified.
2. Disinfecting Mixture:
   a. A chlorine-water solution having a free chlorine residual of 40 ppm to 50 ppm.
   b. Prepare by injecting one of the following:
      1) Liquid chlorine gas-water mixture.
      2) Dry chlorine gas.
      3) Calcium or sodium hypochlorite and water mixture.
   c. Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution or gas is of the specified strength.
   d. Apply liquid chlorine gas-water mixture by means of a chlorinating device.
   e. Feed dry chlorine gas through proper devices for regulating the rate of flow and providing effective diffusion of gas into water within pipe being treated.

f. Chlorinating devices for feeding solutions of chlorine gas or gas itself must prevent backflow of water into chlorine cylinder.
g. Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine).
h. Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1 percent solution.
i. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite1 (65 - 70 percent C1)	1 lb	7.5 gal
Sodium Hypochlorite2 (5.25 percent C1)	1 gal	4.25 gal
1 Comparable to commercial products known as HTH, Perchloron, and Pittchlor. 2 Known as liquid laundry bleach, Clorox, and Purex.		

H. Point of Application:

1. Inject chlorine mixture into pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of pipeline.
2. Control clean water from existing system or another source so it flows slowly into newly installed piping during chlorine application.
3. Manipulate valves so the strong chlorine solution in the line being treated will not flow back into line supplying the water. Use check valves, if necessary.

I. Retention Period:

1. Retain treated water in pipeline for a minimum of 24 hours or long enough to destroy nonspore-forming bacteria.
2. At the end of the retention period, the disinfecting mixture shall have strength of at least 10 ppm of chlorine.
3. Operate valves, hydrants, and other appurtenances during disinfection to assure disinfecting mixture is dispersed into all parts of the pipeline including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
4. Do not place concentrated quantities of commercial disinfectants in pipeline before filling with water.
5. After chlorination, flush water from permanent source of supply until water through pipeline is equal chemically and bacteriologically to permanent source of supply.

J. Disposal of Disinfecting Water:

1. Dispose of disinfecting water in accordance with permits and regulations. Protect the public and receiving waters from harmful or toxic concentrations of chlorine.
2. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

3.11 CORROSION PROTECTION

A. As specified in Section 40 27 00, Process Piping—General.

3.12 PROTECTION OF INSTALLED WORK

A. Protective Covers:

1. Provide over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.
2. Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.
3. Remove at time of Substantial Completion.

3.13 FIELD FINISHING

A. In accordance with Section 40 27 00, Processing Piping—General.

3.14 PIPING IDENTIFICATION

A. Refer to Section 40 27 00, Process Piping—General, and Pipe Schedule.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA).
2. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. American Society of Mechanical Engineer's (ASME).
4. American Society of Sanitary Engineering (ASSE):
   a. 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Backflow Preventers.
   b. 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Backflow Fire Protection Assemblies.
5. American Water Works Association (AWWA):
   a. C510, Double Check Valve Backflow Prevention Assembly.
   b. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   c. C550, Protective Interior Coatings for Valves and Hydrants.
6. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
7. Canadian Standards Association (CSA):
   a. B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
   b. B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
8. FM Global (FM).
9. Food and Drug Administration (FDA).
10. Foundation for Cross-Connection Control and Hydraulic Research at University of Southern California (FCCHR): Manual of Cross-Connection Control.
11. International Code Council (ICC): International Plumbing Code (IPC).
12. National Electrical Code (NEC).
13. National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.

14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s product data.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 SPECIAL GUARANTEE

A. Where note below, provide manufacturer’s extended guarantee in writing with Owner named as beneficiary. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of products found defective during the stated period after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER HEATERS

A. Electric Water Heater (Commercial):

1. Description:
    a. Automatic, vertical, electric storage type.

b. Regulatory Compliance: UL listed, ASME, ASHRAE 90.1, and NSF.
c. Tank: steel, glass-lined, 150 psig working pressure, and ASME rated.
d. Insulation: foam or fiberglass type with minimum R value per ASHRAE 90.1.
e. Dip Tube: required on inlet connection down to bottom section of tank.
f. Anode: heavy-duty, tank-mounted, screw-in type.
g. Pressure/Temperature Relief Valve: ASME rated.
h. Connections: inlet and outlet with factory-installed dielectric unions and brass drain valve with hose thread.
i. Heating Element: watt-density (maximum of 75 watts per square inch) incoloy sheath; immersion type.
j. Controls: Fully automatic, house in hinged control panel, and including the following:
    1) Terminal block.
    2) Close differential immersion-type thermostat.
    3) Control transformer for 120-volt circuit and fusing.
    4) Magnetic contactors for each stage.
    5) Manual reset high-limit switch.
    6) Adjustable temperature range, 95 degrees F to 180 degrees F.
    7) Power circuit fusing as required by NEC and UL.
k. Guarantee: 3 years.

2. Capacity: see schedules on plumbing drawings.
3. Manufacturers:
    a. AO Smith.
    b. Bradford White Corporation.
    c. Lochinvar Corporation.

2.03 DOMESTIC WATER EXPANSION TANK

A. Description:

1. Type: Prepressurized diaphragm type, horizontal or vertical per expansion tank data sheet at end of section.
2. Shell: Welded steel.
3. Diaphragm: FDA-approved, heavy-duty butyl with polypropylene liner.
4. Connection Size: Per expansion tank data sheet at end of section.
5. Maximum Operating Pressure: Per expansion tank data sheet at end of section.
6. Maximum Operating Temperature: Per expansion tank data sheet at end of section.
7. Finish: Manufacturer’s standard air-dry enamel.

B. Capacity: See schedules on plumbing drawings.

C. Manufacturer: AMTROL, Inc.; Model AST.

2.04 BACKFLOW PREVENTERS

A. Reduced-Pressure Backflow Preventers (3/4 Inch Through 2 Inches):

1. Description:
   a. Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013, ICC (IPC).
   b. Valve Body: bronze.
   c. End Connections: threaded, NPT.
   d. Maximum Working Pressure: 175 psi (350 psi test).
   e. Temperature Range: 32 degrees F to 140 degrees F.
   f. Shutoff Valve: full port, resilient seated, bronze ball valve with bronze ball valve test cock.
   g. Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.
   h. Accessories: Drainline air gap fitting.
2. Sizes: See schedules on plumbing drawings.
3. Manufacturers and Products:
   a. Febco; Model 860.
   b. Watts; Model 909.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, arrange, and connect equipment as shown on Drawings and in accordance with manufacturer’s recommendations.

3.02 FIELD QUALITY CONTROL

A. Pumps: Do not hydrostatic test pumps with mechanical seals.

B. Startup:

1. Piping Systems: Verify that flushing, cleaning, and testing has been completed prior to startup.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Americans with Disabilities Act (ADA).
2. American Gas Association (AGA).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
6. Food and Drug Administration (FDA).
7. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
8. Plumbing and Drainage Institute (PDI):
   a. Code Guide 302 and Glossary of Industry Terms.
   b. WH-201, Water Hammer Arrester Standard.
9. UL.

1.02 SUBMITTALS

A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the

Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MANUFACTURERS

A. Emergency Showers and Eyewashes:

1. Haws.
2. Western.
3. Guardian.

B. Drainage Products:

1. General:
   a. Smith.
   b. Wade.
   c. Zurn.

C. Plumbing Specialties:

1. Shock Arresters:
   a. Smith.
   b. Sioux Chief.
   c. Precision Plumbing Products.
2. Pressure/Temperature Relief Valves:
   a. Cash-Acme.
   b. Kunkle Valve.
   c. Watts.
3. Pressure Gauges:
   a. Ashcroft.
   b. Marsh.
   c. Marshalltown.
4. Thermometers:
   a. Trerice.
   b. Weksler.

2.03 GENERAL

A. Plumbing Fixtures: Indicated by fixture number as shown on the Drawings.

B. Drainage Products: Indicated by fixture number as shown on the Drawings.

C. Plumbing Specialties: Indicated by fixture number as shown on the Drawings.

D. Exposed fixture connections and piping shall be polished chrome-plated.

2.04 MATERIALS

A. Plumbing Fixtures.

B. Safety Equipment:

1. SSH-1, Safety Shower/Eyewash Combination (Freeze-proof):
   a. Model: Haws Drinking Faucet Co.; Model 8317CTFPT.
   b. Shower: ABS plastic deluge.
   c. Eyewash: Stainless steel bowl with aerated eye/face wash.
   d. Valve: Stay open.
   e. Support: Freestanding, 1-1/4-inch galvanized pipe standard, stanchion, and floor flange, cable heated and insulated.
   f. Alarms: Magnetically operated proximity switches.

C. Drainage Products:

1. CO-1, Cleanout (Exterior):
   a. Material: Taper thread, bronze plug, heavy-duty, scoriated cast-iron top.
   b. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4263.
2. FD-1, Floor Drain (Unfinished Areas, General Drainage):
   a. Materials: Cast-iron body and grate.
   b. Options: Sediment bucket, Jay R. Smith Mfg. Co.; Model 2696, trap primer connection, vandalproof screws.
   c. Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 2210T-U.
3. HD-1, Hub Drain:
   a. Coated cast-iron reducing hub adapter with standard cast-iron hub.
   b. Hub: Two pipe sizes larger than outlet.

D. Hose Valves: Refer to Section 22 10 01, Plumbing Piping and Accessories.

E. Plumbing Specialties:

1. Water Hammer Arresters:
   a. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.
   b. Manufacturer and Product: Sioux Chief Mfg. Co., Inc.; Series 650 and 660.

2. Pressure/Temperature Relief Valve:
    a. Materials: ASME/AGA rated, bronze body construction, vacuum relief valve vent in drain, backup emergency safety fuse plug, tamper-resistant bonnet screws, test lever, short thermostat, and automatic reseating.
    b. Manufacturer and Product: Watts Industries, Inc.; Series 40.
3. Pressure Gauge:
    a. Materials: 3-1/2-inch gauge size, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/3-inch NPT lower connection.
    b. Manufacturer and Product: Ashcroft Dresser Instrument Division, Dresser Industries, Inc.; Type 1008.
4. Thermometer:
    a. Materials: Adjustable angle, red reading mercury type with 9-inch case and 30 degrees F to 180 degrees F range, 3-1/2-inch aluminum stem, and separate NPT brass thermowell.
    b. Manufacturer and Product: H.O. Trerice Co.; Model A005.

PART 3 EXECUTION

3.01 PREPARATION

A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Engineer for review before proceeding with the Work.

3.02 INSTALLATION

A. Fixture Trim: Install fixture trim where applicable on fixtures.

B. Plumbing Fixtures, Mounting Heights: Standard rough-in catalogued heights, unless shown otherwise on the Drawings.

C. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.

D. Safety Equipment:

1. System Shutoff Valves:
    a. Shutoff valves shall give visual indication of position (open or closed).
    b. Shutoff valves shall be lockable valves and locked in open position.

2. Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements are as follows:
    a. Visually check safety shower/eyewash piping for leaks.
    b. Verify that upon operation, stay-open valves remain open.
    c. Showerheads to be between 82 inches and 96 inches above standing surface.
    d. Shower spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
    e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
    f. Minimum flow rates for safety showers shall be 20 gpm.
    g. Minimum flow rates for eyewashes shall be 3 gpm.
    h. Tempered water shall be temperature indicated on the Drawings.

E. Drainage Products:

1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
2. Cleanouts: Install where shown or required for purposes intended. Set cover flush with finished floor.
3. Hub Drains: Set top of hub 2 inches above finished floor.

F. Plumbing Specialties:

1. Shock Arresters:
    a. Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on the Drawings.
    b. Install adjacent to equipment wherein quick closing valves are installed.
    c. Install at each emergency safety shower.
    d. Shock arresters to have access panels or to be otherwise accessible.
2. Thermometers and Pressure Gauges:
    a. Arrange devices to facilitate use and observation.
    b. Install in orientation that will allow clear observation from ground level.
    c. Provide pressure gauges with block valves.
    d. Install thermometers in thermowells.

G. Caulk penetrations of exterior walls with weatherproof sealant.

H. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, , and terminal device. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.03 FIELD QUALITY CONTROL

A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

B. Notify Owner and Engineer 48 hours prior to shower testing. Owner and Engineer reserve the right to witness all tempered water and safety shower testing.

C. Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.

1. Shower Flow:
    a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 5-gallon container.
    b. Container shall fill in 10 seconds or less, with a minimum 20-gpm flow.
2. Eyewash Flow:
    a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 1-gallon container.
    b. Container shall fill in 20 seconds or less.
3. Contractor shall log, date, and initial inspection upon passing flow tests.

D. Verify alarm operation both locally and systemwide. Notify security prior to test if alarm is connected systemwide.

END OF SECTION

SECTION 26 05 01
ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
2. Federal Specifications (FS):
   a. W-C-596, Connector, Electrical, Power, General Specification for.

3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   d. 114, IEEE Standard Test Procedure for Single-Phase Induction Motors.
4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Electrical Contractor's Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
6. National Electrical Manufacturers Association (NEMA):
   a. C80.1, Rigid Steel Conduit-Zinc Coated.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   c. ICS 1, Industrial Control and Systems: General Requirements.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC.

e. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
f. MG 1, Motors and Generators.
g. PB 1, Panelboards.
h. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
i. ST 20, Dry Type Transformers for General Applications.
j. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
k. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
l. WC 55, Instrumentation Cables and Thermocouple Wire.
m. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
n. WC 71, Standard for Non-Shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electrical Energy.
o. WD 1, General Color Requirements for Wiring Devices.

7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. UL:
   a. 1, Flexible Metal Conduit.
   b. 6, Electrical Rigid Metal Conduit—Steel.

   c. 67, Panelboards.
   f. 98, Enclosed and Dead-Front Switches.
   g. 198C, High Interrupting Capacity Fuses, Current Limiting Types.
   h. 198E, Class R Fuses.
   i. 360, Liquid-Tight Flexible Steel Conduit.
   j. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   k. 486C, Splicing Wire Connectors.
   l. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   m. 508, Industrial Control Equipment.
   n. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
   o. 514B, Fittings for Cable and Conduit.
   p. 651, Schedule 40 and 80 PVC Conduit.
   q. 854, Service-Entrance Cables.
   r. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
   s. 943, Ground-Fault Circuit Interrupters.
   t. 1059, Terminal Blocks.
   u. 1449, Surge Protective Device.
   v. 2111, Overheating Protection for Motors.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. MCOV: Maximum Allowable Continuous Operating Voltage.

C. MOV: Metal Oxide Varistor.

D. SPD: Surge Protective Devices.

1.03 SUBMITTALS

A. Action Submittals:

1. Boxes and device plates.
2. Junction and pullboxes.
3. Wiring devices.
4. Panelboards and mini-power centers.
5. Circuit breakers and switches.
6. Motor-rated switches.
7. Control devices, terminal blocks, and relays.
8. Contactors.

12. Conduit, fittings, and accessories.
13. Wireways.
14. Conductors, cable, and accessories.
15. Motors: Nameplate data, detailed information on any special features.
16. Grounding materials.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test reports.
3. Field test reports.
4. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark or label.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall comply with all applicable provisions of NFPA 70.

B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of 0 degrees F to 104 degrees F.

D. Equipment Finish: Manufacturer's standard finish color, except where specific color is indicated.

2.02 OUTLET AND DEVICE BOXES

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or EAJ.
   b. Appleton; Type GR.

B. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
   a. All Exterior Surfaces; 40 mils PVC.
   b. All Interior Surfaces, 2 mils urethane.
4. Manufacturers:
   a. Robroy Industries.
   b. Ocal.

2.03 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

C. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Nonhinged with screws.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:

D. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
3. Cover: Nonhinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

2.04 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896.
2. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Automatic grounding clip and integral grounding terminal on mounting strap.

6. Manufacturers and Products:
   a. Leviton; 1221 Series.
   b. Bryant; 4901 Series.
   c. Hubbell; 1221 Series.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
5. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
6. One-piece mounting strap with integral ground contact (rivetless construction).
7. Manufacturers and Products:
   a. Arrow Hart; 5262 Series.
   b. Leviton; 5262/5362 Series.
   c. Bryant; 5262/5362 Series.
   d. Hubbell; 5262/5362 Series.

REPLACED WITH CHANGE No.1

1. Duplex, listed Class A to UL Standard 943, tripping at 5 mA.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.
5. Impact resistant nylon face.
6. Manufacturers:
   a. Bryant.
   b. Hubbell.
   c. Leviton.

2.05 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

D. Engraved:

1. Character Height: 1/8 inch.
2. Filler: Black.

E. Weatherproof:

1. For Receptacles, Wet Locations:
   a. Impact-resistant, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating.
   b. Stainless steel mounting and hinge hardware.
   c. Lockable, paintable.
   d. Color: Gray.
   e. Manufacturers:
      1) Carlon.
      2) Leviton.
2. For Switches:

   b. Mounting Screw: Stainless steel.
   c. Manufacturers and Products:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

2.06 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: 22,000 amps rms symmetrical at 480 volts.

C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Enclosure: As specified under Execution.

G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

H. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.07 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: As specified under Execution.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

3. Square D Co.

2.08 SWITCH, MOTOR-RATED

A. Type: Two- or three-pole, manual motor starting/disconnect switch without overload protection.

B. Enclosure/Mounting and Rating:

1. General Purpose:
   a. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. Listed UL 508
   b. General Purpose Rating: 30 amperes, 600V ac.
   c. Minimum Motor Ratings:
      1) 2 hp for 120V ac, single-phase, two-pole.
      2) 3 hp for 240V ac, single-phase, two-pole.
      3) 15 hp for 480V ac, three-phase, three-pole.
   d. Screw-type terminals.

C. Manufacturers:

1. General Purpose:
   a. Bryant.
   b. Hubbell.
2. Explosion-proof: Eaton, Type B101.

2.09 TERMINAL BLOCKS

A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.

B. Yokes and Clamping Screws: Zinc-plated, hardened steel.

C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

REPLACED WITH CHANGE No.1

steel, 12 gauge.

B. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

2.11 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment: Adhesive.

C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Panelboards:
   a. Designation.
   b. Service voltage.
   c. Phases.

3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
2. Equipment and Panelboards: 1/4 inch.

2.12 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.

1. Meet requirements of NEMA RN 1.
2. Material:
   a. Meet requirements of NEMA C80.1 and UL 6.
   b. Exterior Finish : PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2 mils nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to either interior or exterior coating.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized.

3. PVC Conduit:
   a. Meet requirements of NEMA TC 3.
   b. Type: PVC, slip-on.
4. PVC-Coated Rigid Galvanized Steel Conduit:
   a. Meet requirements of UL 514B.
   b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
   c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
   d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
   e. Overlapping pressure sealing sleeves.
   f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
   g. Manufacturers:
      1) Robroy Industries.
      2) Ocal.
   h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
5. Flexible Metal, Liquid-Tight Conduit:
   a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.

   b. Rating: Watertight and UL listed for use in Class I, Division 1 and Division 2 areas.
   c. Outer bronze braid and an insulating liner.
   d. Conductivity equal to a similar length of rigid metal conduit.
   e. Manufacturers and Products:
      1) Crouse-Hinds; Type ECGJH or ECLK.
      2) Appleton; EXGJH or EXLK.

2.13 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating Outdoor raintight.

D. Finish: Gray, baked enamel.

E. Manufacturers:

1. Copper B-Line.
2. Hoffman.

2.14 CONDUIT ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
   a. Underground Device, Inc.
   b. Carlon.

2.15 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type:
   a. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
   b. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
   c. All Other Circuits: Stranded copper.

4. Direct Burial and Aerial Conductors and Cables:
   a. Type USE/RHH/RHW insulation, UL 854 listed or Type RHW-2/USE-2.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.
5. Flexible Cords and Cables:
   a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

1. General:
   a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   c. Suitable for installation in open air, in cable trays, or conduit.

d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

2. Type 3, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   a. Outer Jacket: 45 mils nominal thickness.
   b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   c. Dimension: 0.31-inch nominal outside diameter.
   d. Conductors:
      1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
      2) 20 AWG, seven-strand tinned copper drain wire.
      3) Insulation: 15 mils nominal PVC.
      4) Jacket: 4 mils nominal nylon.
      5) Color Code: Pair conductors black and red.
   e. Manufacturers: Okonite Co.

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   a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
   c. Arc and Fireproofing:
      1) 30 mils, elastomer.
      2) Manufacturers and Products:
         a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
         b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.

2. Identification Devices:
   a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturer and Products: Raychem; Type D-SCE or ZH-SCE.
3. Connectors and Terminations:
   a. Nylon, Self-Insulated Crimp Connectors:
      1) Manufacturers and Products:
         a) Thomas & Betts; Sta-Kon.
         b) Burndy; Insulug.
         c) ILSCO.

4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
5. Cable Lugs:
   a. In accordance with NEMA CC 1.
   b. Rated 600 volts of same material as conductor metal.
   c. Uninsulated Crimp Connectors and Terminators:
      1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
      2) Manufacturers and Products:
         a) Thomas & Betts; Color-Keyed.
         b) Burndy; Hydent.
         c) ILSCO.
   d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
      1) Manufacturers and Products:
         a) Thomas & Betts; Locktite.
         b) Burndy; Quiklug.
         c) ILSCO.

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7. Heat Shrinkable Insulation:
   a. Thermally stabilized, crosslinked polyolefin.
   b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.16 GROUNDING

A. Ground Rods: Provide copper-clad with minimum diameter of 5/8 inch, and length of 10 feet.

B. Ground Conductors: As specified in Article Conductors and Cable.

C. Connectors:

1. Exothermic Weld Type:
   a. Outdoor Weld: Suitable for exposure to elements or direct burial.
   b. Indoor Weld: Use low-smoke, low-emission process.
   c. Manufacturers:
      1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
      2) Thermoweld.
2. Compression Type:
   a. Compress-deforming type; wrought copper extrusion material.
   b. Single indentation for conductors 6 AWG and smaller.

c. Double indentation with extended barrel for conductors 4 AWG and larger.
d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
e. Manufacturers:
1) Burndy Corp.
2) Thomas and Betts Co.
3) ILSCO.

3. Mechanical Type:
a. Split-bolt, saddle, or cone screw type; copper alloy material.
b. Manufacturers:
1) Burndy Corp.
2) Thomas and Betts Co.

PART 3 EXECUTION

3.01 GENERAL

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.

D. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

B. Cap conduit runs during construction with manufactured seals.

C. Close openings in boxes or equipment during construction.

D. Energize space heaters furnished with equipment.

3.03 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Owner.
3. Light Switch: Install on lock side of doors.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.

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2. Switches: 48 inches above floor.
3. Receptacles:
   a. General Indoor Areas: 15 inches above floor.
   b. Outdoor, All Areas: 24 inches above finished grade.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Box Type (Steel Raceway System):

1. Outdoor Locations: Cast metal.
2. Indoor Dry Locations:
   a. Exposed Rigid Conduit: Cast metal.

3. Indoor Wet Locations:
   a. Exposed Raceways: Cast metal.

I. Box Type, Corrosive Locations (PVC-Coated rigid Galvanized Steel Raceway System): PVC-coated cast metal with matching cover.

3.04 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. At or Belowgrade:

1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Use boxes and covers suitable to support anticipated weights.

K. Mounting Hardware: Stainless steel.

L. Location/Type:

1. Indoor and Outdoor, Wet or Corrosive: NEMA 250, Type 4X, stainless steel.
2. Corrosive: NEMA 250, Type 4X, stainless steel.

3. Outdoor, Where Indicated Weatherproof (WP): NEMA 250, Type 3R.
4. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.05 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article Outlet and Device Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Ground receptacles to boxes with grounding wire only.
2. Weatherproof Receptacles:
   a. Install in cast metal box.
   b. Install such that hinge for protective cover is above receptacle opening.

receptacles.

3.06 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Types (Unless Otherwise Shown):

1. Outdoor: Weatherproof.
2. Indoor:
   a. Flush Mounted Boxes: Metal.
   b. Surface Mounted, Metal Boxes: Cast.

3.07 CIRCUIT BREAKERS AND SWITCHES

A. Location and Enclosure Type:

1. Wet or Outdoor: NEMA 250, Type 4X.
2. Corrosive: NEMA 250, Type 4X.
3. Wet and Corrosive: NEMA 250, Type 4X.
4. Indoor Dry, Industrial Use: NEMA 250, Type 12.
5. Indoor Dry, General Purpose: NEMA 250, Type 1.

3.08 SWITCH, MOTOR RATED

A. Install with switch operation in vertical position such that toggle is in up position when ON.

B. Install within sight of motor when used as a disconnect switch.

C. Mounting Height: See Article Outlet and Device Boxes.

D. Enclosure Type:

1. General Purpose: See Articles Outlet and Device Boxes and Device

3.09 TERMINAL BLOCKS

A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.10 SUPPORT AND FRAMING CHANNELS

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry Noncorrosive Locations: Type 316 stainless steel.
2. Interior, Wet or Dry Corrosive Locations: Type 316 stainless steel.
3. Outdoor, Corrosive Locations: Type 316 stainless steel.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.11 NAMEPLATES

A. Provide identifying nameplate on all equipment.

3.12 CONDUIT AND FITTINGS

A. General:

1. Crushed or deformed raceways not permitted.
2. Maintain raceway entirely free of obstructions and moisture.
3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
6. Group raceways installed in same area.
7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
10. Install watertight fittings in outdoor, underground, or wet locations.
11. Paint threads and cut ends, before assembly of fittings, galvanized

installation of conductors, wires, or cables.

13. Do not install raceways in concrete equipment pads, foundations, or beams.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.
3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.

5. Slabs and Walls:
   a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
   b. Install within middle two-fourths of slab or wall.
   c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
   d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
   e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
   f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
   g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
   a. Trade size of conduit not to exceed one-fourth of beam thickness.
   b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

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3. Indoor, Exposed: Rigid galvanized steel.
4. Direct Earth Burial: PVC-coated rigid galvanized steel.
5. Concrete Encased Ductbank: PVC schedule 40 for ac circuits, PVC-coated Rigid Galvanized Steel for dc analog signals.
6. Under Slabs-On-Grade: PVC Schedule 40 for ac circuits, PVC-coated Rigid Galvanized Steel for dc analog signals.
7. Corrosive Areas: PVC-coated rigid galvanized steel.

D. Connections:

1. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
2. Transition From Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.

3. Entering Structures:
   a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
   c. Heating, Ventilating, and Air Conditioning Equipment:
      1) Penetrate equipment in area established by manufacturer.
      2) Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
      3) Seal penetration with Type 5 sealant, as specified.
   d. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
      1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.
      2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.

F. Support:

2. Application/Type of Conduit Strap:
   a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
   b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
   c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
3. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   a. Steelwork: Machine screws.
   b. Location/Type of Hardware:
      1) Dry, Noncorrosive Areas: Galvanized.
      2) Wet, Noncorrosive Areas: Stainless steel.
      3) Corrosive Areas: Stainless steel.

G. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
3. Install with symmetrical bends or cast metal fittings.

4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
7. PVC Conduit:
   a. Bends 30 Degrees and Larger: Provide factory-made elbows.
   b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried.
   c. Use manufacturer's recommended method for forming smaller bends.
8. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.

I. PVC Conduit:

   b. Install such that joint is watertight.
2. Adapters:
   a. PVC to Metallic Fittings: PVC terminal type.
   b. PVC to Rigid Metal Conduit: PVC female adapter.
3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

J. PVC-Coated Rigid Steel Conduit:

1. Install in accordance with manufacturer's instructions.
2. All tools and equipment used in the cutting, bending, threading, and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
3. Provide PVC boot to cover all exposed threading.

K. Termination at Enclosures:

1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.

3. Sheet Metal Boxes, Cabinets, and Enclosures:
   a. Rigid Galvanized Conduit:
      1) Provide one lock nut each on inside and outside of enclosure.
      2) Install grounding bushing.
      3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
      4) Install insulated bushing on ends of conduit where grounding is not required.
      5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
      6) Utilize sealing locknuts or threaded hubs on outside of NEMA 12 enclosures.
      7) Terminate conduits with threaded conduit hubs at NEMA 3R, 4 and 4X boxes and enclosures.
   b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
   c. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.

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L. Underground Raceways:

1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
3. Make routing changes as necessary to avoid obstructions or conflicts.
4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
5. Union type fittings not permitted.
6. Spacers:
   a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
   b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
7. Support conduit so as to prevent bending or displacement during backfilling.
8. Installation with Other Piping Systems:
   a. Crossings: Maintain minimum 12-inch vertical separation.

b. Parallel Runs: Maintain minimum 12-inch separation.
c. Installation over valves or couplings not permitted.

9. Metallic Raceway Coating: Along entire length, coat with raceway coating.
10. Backfill: As specified in Section 31 23 23.15, Trench Backfill.

3.13 METAL WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.14 CONDUCTORS AND CABLES

A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.

B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

C. Conduit system shall be complete prior to drawing conductors. Lubricate prior

D. Terminate all conductors and cables, unless otherwise shown.

E. Do not splice conductors, unless specifically indicated or approved by Engineer.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.

H. Power Conductor Color Coding:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
   a. Neutral Wire: White.
   b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.

c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
e. Ground Wire: Green.

I. Circuit Identification:

1. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
2. Circuits Not Appearing in Circuit Schedules: Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

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instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.15 GROUNDING

A. Grounding shall be in compliance with NFPA 70 and as shown.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.

2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

F. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

G. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

3.16 FIELD QUALITY CONTROL

A. Tests shall be performed in accordance with the requirements in Division 01, General Requirements.

B. General:

1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
2. Test instrument calibration shall be in accordance with NETA ATS.
3. Perform inspection and electrical tests after equipment has been installed.

a. Scheduled with Engineer prior to de-energization.
b. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer's tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

M. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.

having damaged surfaces.
5. Replace missing or damaged hardware.

N. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.

O. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.
3. Motor controls.
4. Grounding electrodes.
5. Motors.

P. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

END OF SECTION

SECTION 26 05 01
ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
2. Federal Specifications (FS):
   a. W-C-596, Connector, Electrical, Power, General Specification for.
   b. W-S-896, Switch, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits.
   c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   d. 114, IEEE Standard Test Procedure for Single-Phase Induction Motors.
4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Electrical Contractor’s Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
6. National Electrical Manufacturers Association (NEMA):
   a. C80.1, Rigid Steel Conduit-Zinc Coated.
   b. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   c. ICS 1, Industrial Control and Systems: General Requirements.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts dc.

e. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
f. MG 1, Motors and Generators.
g. PB 1, Panelboards.
h. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
i. ST 20, Dry Type Transformers for General Applications.
j. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
k. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
l. WC 55, Instrumentation Cables and Thermocouple Wire.
m. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
n. WC 71, Standard for Non-Shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electrical Energy.
o. WD 1, General Color Requirements for Wiring Devices.

7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
8. UL:
   a. 1, Flexible Metal Conduit.
   b. 6, Electrical Rigid Metal Conduit—Steel.
   c. 44, Thermoset Insulated Wires and Cables.
   d. 62, Flexible Cord and Fixture Wire.
   e. 67, Panelboards.
   f. 98, Enclosed and Dead-Front Switches.
   g. 198C, High Interrupting Capacity Fuses, Current Limiting Types.
   h. 198E, Class R Fuses.
   i. 360, Liquid-Tight Flexible Steel Conduit.
   j. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   k. 486C, Splicing Wire Connectors.
   l. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   m. 508, Industrial Control Equipment.
   n. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
   o. 514B, Fittings for Cable and Conduit.
   p. 651, Schedule 40 and 80 PVC Conduit.
   q. 854, Service-Entrance Cables.
   r. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
   s. 943, Ground-Fault Circuit Interrupters.
   t. 1059, Terminal Blocks.
   u. 1449, Surge Protective Device.
   v. 2111, Overheating Protection for Motors.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. MCOV: Maximum Allowable Continuous Operating Voltage.

C. MOV: Metal Oxide Varistor.

D. SPD: Surge Protective Devices.

1.03 SUBMITTALS

A. Action Submittals:

1. Boxes and device plates.
2. Junction and pullboxes.
3. Wiring devices.
4. Transformers.
~~4.~~5. Panelboards and mini-power centers.
~~5.~~6. Circuit breakers and switches.
~~6.~~7. Motor-rated switches.
~~7.~~8. Control devices, terminal blocks, and relays.
~~8.~~9. Contactors.
~~9.~~10. Support and framing channels.
~~10.~~11. Nameplates and nameplate schedule.
~~11.~~12. SPD equipment.
~~12.~~13. Conduit, fittings, and accessories.
~~13.~~14. Wireways.
~~14.~~15. Conductors, cable, and accessories.
~~15.~~16. Motors: Nameplate data, detailed information on any special features.
~~16.~~17. Grounding materials.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory test reports.
3. Field test reports.
4. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL, shall conform to those standards and shall have an applied UL listing mark or label.

PART 2 PRODUCTS

2.01 GENERAL

A. Products shall comply with all applicable provisions of NFPA 70.

B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of 0 degrees F to 104 degrees F.

D. Equipment Finish: Manufacturer's standard finish color, except where specific color is indicated.

2.02 OUTLET AND DEVICE BOXES

A. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or FD.
   b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
   a. Crouse-Hinds; Type GUA or EAJ.
   b. Appleton; Type GR.

B. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
   a. All Exterior Surfaces; 40 mils PVC.
   b. All Interior Surfaces, 2 mils urethane.
4. Manufacturers:
   a. Robroy Industries.
   b. Ocal.

2.03 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

C. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Nonhinged with screws.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds; Series W.
   b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:
   a. Crouse-Hinds; Type WJBF.
   b. O-Z/Gedney; Series YR.

D. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
3. Cover: Nonhinged with screws.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.

2.04 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896.
2. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Automatic grounding clip and integral grounding terminal on mounting strap.
6. Manufacturers and Products:
    a. Leviton; 1221 Series.
    b. Bryant; 4901 Series.
    c. Hubbell; 1221 Series.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
5. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
6. One-piece mounting strap with integral ground contact (rivetless construction).
7. Manufacturers and Products:
    a. Arrow Hart; 5262 Series.
    b. Leviton; 5262/5362 Series.
    c. Bryant; 5262/5362 Series.
    d. Hubbell; 5262/5362 Series.

C. Receptacle, Ground Fault Circuit Interrupter:

1. Duplex, listed Class A to UL Standard 943, tripping at 5 mA.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.
5. Impact resistant nylon face.
6. Manufacturers:
    a. Bryant.
    b. Hubbell.
    c. Leviton.

2.05 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Malleable ferrous metal, with gaskets.
2. Screw: Oval-head stainless steel.

D. Engraved:

1. Character Height: 1/8 inch.
2. Filler: Black.

E. Weatherproof:

1. For Receptacles, Wet Locations:
   a. Impact-resistant, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating.
   b. Stainless steel mounting and hinge hardware.
   c. Lockable, paintable.
   d. Color: Gray.
   e. Manufacturers:
      1) Carlon.
      2) Leviton.
2. For Switches:
   a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
   c. Manufacturers and Products:
      1) Crouse-Hinds; DS-181 or DS-185.
      2) Appleton; FSK-1VTS or FSK-1VS.

2.06 DRY TYPE POWER TRANSFORMERS (0- TO 600-VOLT PRIMARY)

A. Type: Self-cooled, two-winding.

B. UL 1561 and NEMA ST 20.

C. Insulation Class, Temperature Rise, and Impedance: Manufacturer’s standard.

D. Core and Coil:

1. 30 kVA or Less: Encapsulated.

E. Enclosure:

1. 30 kVA or Less: NEMA 250, Type 3R, nonventilated.

F. Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

G. Sound Level: Not to exceed NEMA ST 20 levels.

H. Vibration isolators to minimize and isolate sound transmission.

I. Manufacturers:

1. General Electric.
2. Eaton.
3. Square D.

2.07 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. NEMA PB 1, NFPA 70, and UL 67.

B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.

D. Rating: Applicable to a system with available short-circuit current of 22,000 amperes rms symmetrical at 208Y/120 or 120/240 volts.

E. Cabinet:

1. NEMA 250, Type 4X.
2. Material: Type 316 stainless steel.
3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
4. Front: Fastened with adjustable clamps.
   a. Trim Size: As required by mounting.
   b. Finish: Manufacturer’s standard.
5. Interior:
   a. Factory assembled; complete with circuit breakers.
   b. Spaces: Cover openings with easily removable metal cover.
6. Door Hinges: Concealed.

7. Locking Device:
   a. Flush type.
   b. Doors Over 30 Inches in Height: Multipoint.
   c. Identical keylocks, with two milled keys each lock.
8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

F. Bus Bar:

1. Material: Copper full sized throughout length.
2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
4. Lugs and Connection Points:
   a. Suitable for either copper or aluminum conductors.
   b. Solderless main lugs for main, neutral, and ground bus bars.
   c. Subfeed or through-feed lugs as shown.

G. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.
4. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
5. Do not use tandem or dual circuit breakers in normal single-pole spaces.
6. Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.
7. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

H. Surge Arresters: Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.

I. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

~~2.06~~2.08 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. UL 489 listed for use at location of installation.

B. Minimum Interrupt Rating: 22,000 amps rms symmetrical at 480 volts.

C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.

D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Locking: Provisions for padlocking handle.

F. Enclosure: As specified under Execution.

G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

H. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

~~2.07~~2.09 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: As specified under Execution.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

~~2.08~~2.10 SWITCH, MOTOR-RATED

A. Type: Two- or three-pole, manual motor starting/disconnect switch without overload protection.

B. Enclosure/Mounting and Rating:

1. General Purpose:
   a. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. Listed UL 508.
   b. General Purpose Rating: 30 amperes, 600V ac.
   c. Minimum Motor Ratings:
      1) 2 hp for 120V ac, single-phase, two-pole.
      2) 3 hp for 240V ac, single-phase, two-pole.
      3) 15 hp for 480V ac, three-phase, three-pole.
   d. Screw-type terminals.

C. Manufacturers:

1. General Purpose:
   a. Bryant.
   b. Hubbell.
2. Explosion-proof: Eaton, Type B101.

~~2.09~~2.11 TERMINAL BLOCKS

A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.

B. Yokes and Clamping Screws: Zinc-plated, hardened steel.

C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

~~2.10~~2.12 SUPPORT AND FRAMING CHANNELS

A. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

B. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

~~2.11~~2.13 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment: Adhesive.

C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Panelboards:
   a. Designation.
   b. Service voltage.
   c. Phases.
3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
2. Equipment and Panelboards: 1/4 inch.

~~2.12~~2.14 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.

C. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.

2. Material:
    a. Meet requirements of NEMA C80.1 and UL 6.
    b. Exterior Finish : PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
    c. Interior finish: Urethane coating, 2 mils nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to either interior or exterior coating.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
    a. Meet requirements of UL 514B.
    b. Type: Threaded, galvanized.
3. PVC Conduit:
    a. Meet requirements of NEMA TC 3.
    b. Type: PVC, slip-on.
4. PVC-Coated Rigid Galvanized Steel Conduit:
    a. Meet requirements of UL 514B.
    b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
    c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
    d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
    e. Overlapping pressure sealing sleeves.
    f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
    g. Manufacturers:
        1) Robroy Industries.
        2) Ocal.
    h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
5. Flexible Metal, Liquid-Tight Conduit:
    a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
    b. Insulated throat and sealing O-rings.
6. Flexible Coupling, Hazardous Locations:
    a. Approved for use in the atmosphere involved.

b. Rating: Watertight and UL listed for use in Class I, Division 1 and Division 2 areas.
c. Outer bronze braid and an insulating liner.
d. Conductivity equal to a similar length of rigid metal conduit.
e. Manufacturers and Products:
   1) Crouse-Hinds; Type ECGJH or ECLK.
   2) Appleton; EXGJH or EXLK.

~~2.13~~2.15 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Steel-enclosed, with removable, hinged cover.

C. Rating Outdoor raintight.

D. Finish: Gray, baked enamel.

E. Manufacturers:

1. Copper B-Line.
2. Hoffman.

~~2.14~~2.16 CONDUIT ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
   a. Underground Device, Inc.
   b. Carlon.

~~2.15~~2.17 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type:
   a. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
   b. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
   c. All Other Circuits: Stranded copper.
3. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation.

4. Direct Burial and Aerial Conductors and Cables:
   a. Type USE/RHH/RHW insulation, UL 854 listed or Type RHW-2/USE-2.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.
5. Flexible Cords and Cables:
   a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
   b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

1. General:
   a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
   c. Suitable for installation in open air, in cable trays, or conduit.
   d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
   e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
2. Type 3, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
   a. Outer Jacket: 45 mils nominal thickness.
   b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   c. Dimension: 0.31-inch nominal outside diameter.
   d. Conductors:
      1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
      2) 20 AWG, seven-strand tinned copper drain wire.
      3) Insulation: 15 mils nominal PVC.
      4) Jacket: 4 mils nominal nylon.
      5) Color Code: Pair conductors black and red.
   e. Manufacturers: Okonite Co.

C. Accessories:

1. Tape:
   a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
   b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
   c. Arc and Fireproofing:
      1) 30 mils, elastomer.
      2) Manufacturers and Products:
         a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
         b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
2. Identification Devices:
   a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturer and Products: Raychem; Type D-SCE or ZH-SCE.
3. Connectors and Terminations:
   a. Nylon, Self-Insulated Crimp Connectors:
      1) Manufacturers and Products:
         a) Thomas & Betts; Sta-Kon.
         b) Burndy; Insulug.
         c) ILSCO.
4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. Plated steel, square wire springs.
   b. UL Standard 486C.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
5. Cable Lugs:
   a. In accordance with NEMA CC 1.
   b. Rated 600 volts of same material as conductor metal.
   c. Uninsulated Crimp Connectors and Terminators:
      1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
      2) Manufacturers and Products:
         a) Thomas & Betts; Color-Keyed.
         b) Burndy; Hydent.
         c) ILSCO.
   d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
      1) Manufacturers and Products:
         a) Thomas & Betts; Locktite.
         b) Burndy; Quiklug.
         c) ILSCO.

6. Cable Ties:
   a. Nylon, adjustable, self-locking, and reusable.
   b. Manufacturer and Product: Thomas & Betts; TY-RAP.
7. Heat Shrinkable Insulation:
   a. Thermally stabilized, crosslinked polyolefin.
   b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

~~2.16~~2.18 GROUNDING

A. Ground Rods: Provide copper-clad with minimum diameter of 5/8 inch, and length of 10 feet.

B. Ground Conductors: As specified in Article Conductors and Cable.

C. Connectors:

1. Exothermic Weld Type:
   a. Outdoor Weld: Suitable for exposure to elements or direct burial.
   b. Indoor Weld: Use low-smoke, low-emission process.
   c. Manufacturers:
      1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
      2) Thermoweld.
2. Compression Type:
   a. Compress-deforming type; wrought copper extrusion material.
   b. Single indentation for conductors 6 AWG and smaller.
   c. Double indentation with extended barrel for conductors 4 AWG and larger.
   d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
   e. Manufacturers:
      1) Burndy Corp.
      2) Thomas and Betts Co.
      3) ILSCO.
3. Mechanical Type:
   a. Split-bolt, saddle, or cone screw type; copper alloy material.
   b. Manufacturers:
      1) Burndy Corp.
      2) Thomas and Betts Co.

PART 3 EXECUTION

3.01 GENERAL

A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.

B. Work shall comply with all applicable provisions of NECA 1.

C. Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.

D. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.

B. Cap conduit runs during construction with manufactured seals.

C. Close openings in boxes or equipment during construction.

D. Energize space heaters furnished with equipment.

3.03 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Owner.
3. Light Switch: Install on lock side of doors.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, mount as directed by Owner.
2. Switches: 48 inches above floor.
3. Receptacles:
   a. General Indoor Areas: 15 inches above floor.
   b. Outdoor, All Areas: 24 inches above finished grade.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.

G. Support boxes independently of conduit by attachment to building structure or structural member.

H. Box Type (Steel Raceway System):

1. Outdoor Locations: Cast metal.
2. Indoor Dry Locations:
   a. Exposed Rigid Conduit: Cast metal.
3. Indoor Wet Locations:
   a. Exposed Raceways: Cast metal.

I. Box Type, Corrosive Locations (PVC-Coated rigid Galvanized Steel Raceway System): PVC-coated cast metal with matching cover.

3.04 JUNCTION AND PULL BOXES

A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. At or Belowgrade:

1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Use boxes and covers suitable to support anticipated weights.

K. Mounting Hardware: Stainless steel.

L. Location/Type:

1. Indoor and Outdoor, Wet or Corrosive: NEMA 250, Type 4X, stainless steel.
2. Corrosive: NEMA 250, Type 4X, stainless steel.
3. Outdoor, Where Indicated Weatherproof (WP): NEMA 250, Type 3R.
4. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.05 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article Outlet and Device Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Ground receptacles to boxes with grounding wire only.
2. Weatherproof Receptacles:
   a. Install in cast metal box.

b. Install such that hinge for protective cover is above receptacle opening.

3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

3.06 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Types (Unless Otherwise Shown):

1. Outdoor: Weatherproof.
2. Indoor:
   a. Flush Mounted Boxes: Metal.
   b. Surface Mounted, Metal Boxes: Cast.

3.07 DRY TYPE POWER TRANSFORMERS (0- TO 600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture-proof flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Provide wall brackets where required.

3.08 PANELBOARDS AND MINI-POWER CENTERS

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor, unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

D. Cabinet Location/Type:

1. Indoor Dry: NEMA 250, Type 1.
2. Wet or Outdoor: NEMA 250, Type 3R, Outdoor.
3. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

~~3.07~~3.09 CIRCUIT BREAKERS AND SWITCHES

A. Location and Enclosure Type:

1. Wet or Outdoor: NEMA 250, Type 4X.
2. Corrosive: NEMA 250, Type 4X.
3. Wet and Corrosive: NEMA 250, Type 4X.
4. Indoor Dry, Industrial Use: NEMA 250, Type 12.
5. Indoor Dry, General Purpose: NEMA 250, Type 1.

~~3.08~~3.10 SWITCH, MOTOR RATED

A. Install with switch operation in vertical position such that toggle is in up position when ON.

B. Install within sight of motor when used as a disconnect switch.

C. Mounting Height: See Article Outlet and Device Boxes.

D. Enclosure Type:

1. General Purpose: See Articles Outlet and Device Boxes and Device Plates.
2. Explosion-proof: See product specification.

~~3.09~~3.11 TERMINAL BLOCKS

A. Install for termination of control circuits entering or leaving equipment and local control panels.

~~3.10~~3.12 SUPPORT AND FRAMING CHANNELS

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry Noncorrosive Locations: Type 316 stainless steel.
2. Interior, Wet or Dry Corrosive Locations: Type 316 stainless steel.
3. Outdoor, Corrosive Locations: Type 316 stainless steel.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

~~3.11~~3.13 NAMEPLATES

A. Provide identifying nameplate on all equipment.

~~3.12~~3.14 CONDUIT AND FITTINGS

A. General:

1. Crushed or deformed raceways not permitted.
2. Maintain raceway entirely free of obstructions and moisture.
3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
6. Group raceways installed in same area.
7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
10. Install watertight fittings in outdoor, underground, or wet locations.
11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
13. Do not install raceways in concrete equipment pads, foundations, or beams.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.

3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.
5. Slabs and Walls:
    a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
    b. Install within middle two-fourths of slab or wall.
    c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
    d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
    e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
    f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
    g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
    a. Trade size of conduit not to exceed one-fourth of beam thickness.
    b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

1. Diameter: Minimum 3/4 inch.
2. Outdoor, Exposed: PVC-coated rigid galvanized steel.
3. Indoor, Exposed: Rigid galvanized steel.
4. Direct Earth Burial: PVC-coated rigid galvanized steel.
5. Concrete Encased Ductbank: PVC schedule 40 for ac circuits, PVC-coated Rigid Galvanized Steel for dc analog signals.
6. Under Slabs-On-Grade: PVC Schedule 40 for ac circuits, PVC-coated Rigid Galvanized Steel for dc analog signals.
7. Corrosive Areas: PVC-coated rigid galvanized steel.

D. Connections:

1. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
2. Transition From Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Entering Structures:
   a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
   b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
   c. Heating, Ventilating, and Air Conditioning Equipment:
      1) Penetrate equipment in area established by manufacturer.
      2) Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
      3) Seal penetration with Type 5 sealant, as specified.
   d. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
      1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.
      2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.

F. Support:

1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.
2. Application/Type of Conduit Strap:
   a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
   b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
   c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
3. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
   a. Steelwork: Machine screws.
   b. Location/Type of Hardware:
      1) Dry, Noncorrosive Areas: Galvanized.
      2) Wet, Noncorrosive Areas: Stainless steel.
      3) Corrosive Areas: Stainless steel.

G. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
3. Install with symmetrical bends or cast metal fittings.
4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
7. PVC Conduit:
   a. Bends 30 Degrees and Larger: Provide factory-made elbows.
   b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried.
   c. Use manufacturer's recommended method for forming smaller bends.
8. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.

I. PVC Conduit:

1. Solvent Welding:
   a. Provide manufacturer recommended solvent; apply to all joints.
   b. Install such that joint is watertight.
2. Adapters:
   a. PVC to Metallic Fittings: PVC terminal type.
   b. PVC to Rigid Metal Conduit: PVC female adapter.
3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.

J. PVC-Coated Rigid Steel Conduit:

1. Install in accordance with manufacturer's instructions.
2. All tools and equipment used in the cutting, bending, threading, and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
3. Provide PVC boot to cover all exposed threading.

K. Termination at Enclosures:

1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
3. Sheet Metal Boxes, Cabinets, and Enclosures:
    a. Rigid Galvanized Conduit:
        1) Provide one lock nut each on inside and outside of enclosure.
        2) Install grounding bushing.
        3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
        4) Install insulated bushing on ends of conduit where grounding is not required.
        5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
        6) Utilize sealing locknuts or threaded hubs on outside of NEMA 12 enclosures.
        7) Terminate conduits with threaded conduit hubs at NEMA 3R, 4 and 4X boxes and enclosures.
    b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
    c. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
    d. PVC Schedule 40 Conduit: Provide PVC terminal adapter with locknut.

L. Underground Raceways:

1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
3. Make routing changes as necessary to avoid obstructions or conflicts.
4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
5. Union type fittings not permitted.
6. Spacers:
    a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.

b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

7. Support conduit so as to prevent bending or displacement during backfilling.
8. Installation with Other Piping Systems:
   a. Crossings: Maintain minimum 12-inch vertical separation.
   b. Parallel Runs: Maintain minimum 12-inch separation.
   c. Installation over valves or couplings not permitted.
9. Metallic Raceway Coating: Along entire length, coat with raceway coating.
10. Backfill: As specified in Section 31 23 23.15, Trench Backfill.

~~3.13~~3.15 METAL WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

~~3.14~~3.16 CONDUCTORS AND CABLES

A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.

B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.

D. Terminate all conductors and cables, unless otherwise shown.

E. Do not splice conductors, unless specifically indicated or approved by Engineer.

F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.

G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.

H. Power Conductor Color Coding:

1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
2. No. 8 AWG and Smaller: Provide colored conductors.
3. Colors:
   a. Neutral Wire: White.
   b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
   c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
   d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
   e. Ground Wire: Green.

I. Circuit Identification:

1. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.
2. Circuits Not Appearing in Circuit Schedules: Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
3. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

~~3.15~~3.17 GROUNDING

A. Grounding shall be in compliance with NFPA 70 and as shown.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

E. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

F. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.

G. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

~~3.16~~3.18 FIELD QUALITY CONTROL

A. Tests shall be performed in accordance with the requirements in Division 01, General Requirements.

B. General:

1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
2. Test instrument calibration shall be in accordance with NETA ATS.
3. Perform inspection and electrical tests after equipment has been installed.
4. Perform tests with apparatus de-energized whenever feasible.
5. Inspection and electrical tests on energized equipment are to be:
   a. Scheduled with Engineer prior to de-energization.
   b. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Tests and inspection shall establish that:

1. Electrical equipment is operational within industry and manufacturer’s tolerances.
2. Installation operates properly.
3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and NFPA 70.

D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents.

H. Properly anchor electrical equipment found to be inadequately anchored.

I. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.

J. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

K. Provide proper lubrication of applicable moving parts.

L. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

M. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
5. Replace missing or damaged hardware.

N. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.

O. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.

3. Motor controls.
4. Grounding electrodes.
5. Motors.

P. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Stripping: Removal of topsoil remaining after applicable scalping is completed.

E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 0.5 acres.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping 2 feet beyond toe of permanent fill.
4. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat finished appearance.
5. Roadways: As shown.
6. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing to within 6 inches of ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.06 STRIPPING

A. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

B. Stockpile strippings, meeting requirements of Section 32 91 13, Soil Preparation, for topsoil, separately from other excavated material.

3.07 TREE REMOVAL OUTSIDE CLEARING LIMITS

A. Remove Within Project Limits: Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.

B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.08 PRUNING

A. Remove branches below the following heights:

1. 20 feet above roadways and shoulders.
2. 6 feet above roofs.

3.09 SALVAGE

A. Saleable log timber may be sold to Contractor's benefit. Promptly remove from Project Site.

3.10 DISPOSAL

A. Clearing and Grubbing Debris:

1. Dispose of debris offsite.
2. Burning of debris onsite will not be allowed.
3. Dispose of unburned and noncombustible debris offsite.
4. Woody debris may be chipped. Chips may be sold to Contractor's benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used onsite shall be 1/4 inch by 2 inches. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
5. Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil approved by Engineer.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Compact upper 12 inches to minimum of 92 percent relative compaction as determined in accordance with ASTM D1557.

B. Under Floor Slabs On Grade, gravel roads, and excavated subgrades for foundation slabs: Compact the upper 12 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. Proof-roll with a fully loaded tandem axle dump truck (20-ton capacity) or similar equipment to detect soft or loose subgrade. Correct per Article Correction.

B. In-Place Density Tests: In accordance with ASTM D6938. As a minimum, test as follows:

1. One in-place density test for each prepared subgrade per structure or per 1,500 square feet.

C. Additional tests as determined by the Engineer, if tests results indicate compaction does not meet Specifications.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact, or
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.02 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.03 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.04 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite

B. Dispose of debris resulting from removal of underground facilities offsite.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Standard Specifications: When referenced in this section, shall mean the 2013 edition of the Georgia Department of Transportation Standard Specifications for Construction of Transportation System.

1.03 SUBMITTALS

A. Action Submittals:

1. Approach and plan for quality control testing, including name and qualifications of the Contractor's Independent Testing Laboratory.
2. Waste Disposal and Stockpile Work Plan.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 10, Structural Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 10, Structural Concrete.

D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled, and Engineer provides authorization to backfill.

E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, test as follows:
   a. Structural Fill: Two tests per source location,
   b. Graded Aggregate Base: Two tests per source location.

2.02 EARTHFILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 STRUCTURAL FILL

A. Excavated material from required excavations and designated borrow sites:

1. USCS Classification: SP, SM, SC, SM-ML, ML in accordance with ASTM D2487.
2. Free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.
3. Maximum fine Content (Percent Passing No. 200 sieve): 49.
4. Maximum Liquid Limit: 45.
5. Maximum Plasticity Index: 15.

B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.

C. Provide imported material of equivalent quality, if required to accomplish Work.

2.04 GRANULAR FILL

A. 1-1/2-inch minus crushed gravel or crushed rock, GDOT No. 57 coarse aggregate.

B. Free from dirt, clay balls, and organic material.

2.05 GRADED AGGREGATE BASE

A. As specified in Section 32 11 23, Aggregate Base Courses.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.

3.03 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:

1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 8-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. One sample from each 1,500 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. One in-place density test for each one-foot lift per 2,500 square feet.
2. Additional tests as determined by the Engineer, if tests results indicate compaction does not meet specifications.

3.05 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Courses.

3.06 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Structural fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
    a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    b. Steep Slopes (Steeper than 3:1):
        1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
        2) Backfilling overexcavated areas is prohibited, unless in Engineer’s opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.07 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. Place fill over geosynthetics with sufficient care so as not to damage them.
2. Place fill only by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

B. Spreading:

1. Spreading equipment shall be track mounted low ground pressure, D-6 or lighter.
2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
4. Flatten wrinkles of geotextiles in direction of spreading. Correct wrinkles in geotextiles as specified in Section 31 32 19.16, Geotextile.
5. Maintain proper overlap of unseamed geosynthetics.
6. Avoid overstressing geosynthetics and seams.

C. Geosynthetic Damage:

1. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
2. Clear overlying fill as necessary to repair damage.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:

1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s descriptive literature for marking tapes.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 4 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

B. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRENCH STABILIZATION MATERIAL

A. GDOT No. 357 coarse aggregate.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Ductile iron pipes and concrete pipes: Material classified as SP, SM, and SM-ML, in accordance with ASTM D2487, with following requirements:

1. Maximum Fine Content = 35.
2. Non-Plastic.

C. Electrical conduits, copper pipe, PVC and HDPE pipes: Use excavated material from trench excavation. Where additional material is necessary, use Earthfill as specified in Section 31 23 23, Fill and Backfill.

2.04 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.05 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.06 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.07 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Trench stabilization material.
2. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: As follows:

1. Pipe 15 Inches and Smaller: 4 inches.
2. Pipe 18 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

3.05 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls. Take care to avoid damaging pipe and pipe coating.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
2. Nondetectable Marking Tape: Install with metallic piping.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
4. In other areas fill trench section as shown.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).
   g. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2700 kN-m/m^3)).
   h. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   i. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   j. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   k. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   l. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
   o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

F. Standard Specifications: When referenced in this section, shall mean the 2013 edition of the Georgia Department of Transportation Standard Specifications for Construction of Transportation System.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 30 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 BASE COURSE

A. Graded Aggregate Base, as specified for Group I Aggregates in Section 815 of the Standard Specifications.

2.02 LEVELING COURSE AND GRAVEL SURFACING

A. Size No. 56 or No. 57 coarse aggregates as specified in Section 800 of the Standard Specifications.

B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone.

2.03 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Aggregate Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
    a. Use leveling course or surfacing material as keystone.
    b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
    c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
    d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 4 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base after spreading operations and continue until density of 95 percent of maximum density has been achieved as determined by ASTM D1557.

B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to required density before succeeding lift is placed.

F. Remove floating or loose stone from surface of preceding course before placing leveling course.

G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests: In accordance with ASTM D6938.

1. Construct base course so areas shall be ready for testing.
2. Frequency: Perform a minimum of one test on completed course per 3,000 square feet.

3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   k. C150, Standard Specification for Portland Cement.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   o. F626, Standard Specification for Fence Fittings.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   q. F900, Standard Specification for Industrial and Commercial Swing Gates.
   r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
   s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
w. F1379, Standard Terminology Relating to Barbed Tape.
x. F1911, Standard Practice for Installation of Barbed Tape.
y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
      5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions.
      6) Accessories: Barbed wire.

B. Informational Submittals:

1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.05 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Deflection of fence fabric beyond limits.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 POSTS

A. General:

1. Strength and Stiffness Requirements: ASTM F1043, light industrial fence, except as modified in this section.
2. Round Steel Pipe, Schedule 40: ASTM F1083.
3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
4. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5. Protective Coatings:
   a. Zinc Coating: ASTM F1043, Type A external and internal coating.
6. Color Coating: ASTM F1043, minimum 10 mils thickness over zinc coating to match color of chain link fabric.

B. Line Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.375 inches.

C. End, Corner, Angle, and Pull Posts:

1. Round Steel Pipe:
   a. Outside Diameter: 2.875 inches.
   b. Weight: 5.79 pounds per foot.

2.03 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:

1. ASTM F1083.
2. Outside Diameter: 1.66 inches.
3. Weight: 2.27 pounds per foot.

B. Galvanized Roll-Formed Steel C Shapes:

1. Roll formed from ASTM A1011/A1011M, Grade 45.
2. Outside Dimensions: 1.625 inches by 1.25 inches.
3. Weight: 1.40 pounds per foot.

C. Protective Coatings: As specified for posts.

D. Color Coating: ASTM F1043, minimum 10-mil thickness over zinc coating.

E. Strength and Stiffness Requirements: ASTM F1043, top rail, light industrial fence.

2.04 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:

1. One-piece vinyl-clad.
2. Length not less than 2 inches shorter than full height of chain link fabric.
3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single 45-degree arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.

2.05 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.06 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade.

2.07 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
2. Metal Pipe and Tubing: Galvanized steel. Comply with ASTM F1043 and ASTM F1083 for materials and protective coatings.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8 feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
5. Gate Fabric Height: Same as for adjacent fence height.
6. Welded Steel Joints: Paint with zinc-based paint.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for single and or double swing gate types.

1. Leaf Width: As shown.
2. Hinges: Offset type, malleable iron.
   a. Furnished with large bearing surfaces for clamping in position.
   b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.

3. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.
6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.

C. Cantilever Horizontal Sliding Gates:

1. Comply with ASTM F1184 for single slide gate types 1 with external roller assemblies.
2. Cantilever Gate Support Posts: Spaced on maximum 10-foot centers.
3. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, designed to support size, weight, width, operation, and design of gate and roller assemblies.
4. Roller Guards: As required per ASTM F1184 for Type II, Class 1 gate.
5. Hangers, roller assemblies, and stops fabricated from galvanized malleable iron.

2.08 CONCRETE

A. Provide as specified in Section 03 30 10, Structural Concrete.

2.09 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

1. Connectors for Below-Grade Use: Exothermic welded type.
2. Grounding Rods: Copper-clad steel.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.

1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.
2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.
3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 BARBED WIRE

A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.09 GATES

A. Install gates according to manufacturer’s written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.

B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.10 ELECTRICAL GROUNDING

A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.11 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

3.12 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.02 SUBMITTALS

A. Informational Submittals:

1. Certified Topsoil Analysis Reports:
   a. Indicate quantities of materials necessary to bring onsite topsoil into compliance with textural/gradation requirements.
   b. Indicate quantity of lime, quantity and analysis of fertilizer, and quantity and type of soil additive.

1.03 SEQUENCING AND SCHEDULING

A. Perform Work specified in Section 31 10 00, Site Clearing, prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: In general accordance with ASTM D5268:

1. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.

2. Sand-Sized Fraction: Minimum 20 to 60 percent passing No. 10 sieve.
3. Silt and Clay-Sized Fraction: Minimum 35 to 70 percent.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.

D. pH: Range 5.0 to 7.0.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing. Import topsoil if onsite material is insufficient in quantity.

2.02 LIME

A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.

B. Gradation:

1. Minimum 50 percent passing No. 100 sieve.
2. Minimum 90 percent passing No. 20 sieve.
3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

2.03 SOIL ADDITIVES

A. Sawdust or Ground Bark:

1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.

B. Peat:

1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
   a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.
   b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer:

1. Natural:
   a. Manure:
      1) Well-rotted, stable or cattle manure, free from weed seed and refuse.
      2) Maximum 50 percent sawdust or shavings by volume.
      3) Age: Minimum 4 months; maximum 2 years.
2. Commercial:
   a. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
   b. Contain the following minimum percentage of plant food by weight: As recommended by Certified Topsoil Analysis Reports

D. Sand: Fine Aggregates as specified in Section 03 30 10, Structural Concrete.

2.04 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Apply lime at the rate of recommended by Certified Topsoil Analysis Reports to subgrade before tilling.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

C. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth 6 inches where seeding and planting are scheduled.

D. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 8 weeks after all planting under this section is completed.

B. Satisfactory Stand: Grass or section of grass of 4,000 square feet or larger that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed: Certification of seed analysis, germination rate, and inoculation:
   a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
      1) Name and address of laboratory.
      2) Date of test.
      3) Lot number for each seed specified.
      4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
   b. Mixtures: Proportions of each kind of seed.
2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
3. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work specified in Section 32 91 13, Soil Preparation, before starting Work of this section.

B. Complete Work under this section within 7 days following completion of soil preparation.

C. Notify Engineer in advance of start of planting activity.

D. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

A. Contractor: Perform maintenance operations during maintenance period to include:

1. Watering: Keep surface moist.
2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
3. Mulch: Replace wherever and whenever washed or blown away.
4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
5. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
6. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.
7. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.

B. Application Rates: Determined by soil analysis results.

C. Mix: Determined by soil analysis results.

2.02 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer’s instructions.

C. Warm Season Seed Mix: Indiangrass.

D. Cool Season Seed Mix: Tall Fexcue.

2.03 STRAW MULCH

A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

2.04 HYDROSEEDING MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

2.05 TACKIFIER

A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

1. Capable of hydrating in water, and to readily blend with other slurry materials.
2. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.
3. Manufacturers and Products:
   a. Chevron Asphalt Co.; CSS 1.
   b. Terra; Tack AR.
   c. J Tack; Reclamare.

PART 3 EXECUTION

3.01 PREPARATION

A. Grade areas to smooth, even surface with loose, uniformly fine texture.

1. Roll and rake, remove ridges, fill depressions to meet finish grades.
2. Limit such Work to areas to be planted within immediate future.
3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.

B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.

C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

A. Apply evenly over area in accordance with manufacturer’s instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.

B. Application Rate: Determined by soil test results in accordance with Section 32 91 13, Soil Preparation.

3.03 SEEDING

A. Start within 2 days of preparation completion.

B. Hydroseed slopes steeper than 3H:1V. Flatter slopes may be mechanically seeded.

C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate but no less than 10 pounds per acre for Cool Season mix and 20 pounds per acre for Warm Season mix.
2. Use Brillion type seeder.
3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
4. Roll with ring roller to cover seed, and water with fine spray.

D. Hydroseeding:

1. Application Rate: 15 pounds per acre.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

E. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.

F. Tackifier: Apply over mulched areas with slopes steeper than 4:1 at rate of 5 gallons per 1,000 square feet in accordance with the manufacturers recommended requirements.

G. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

A. 8 weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 05 16.13
PRECAST CONCRETE UTILITY STRUCTURE

PART 1 GENERAL

1.01 SCOPE

A. This section covers the design, materials, fabrication, erection and related operations required to furnish and install the following precast concrete structures as shown on the Drawings:

1. 3 feet – 0 inch by 3 feet – 0 inch (inside dimensions) Square Manhole with integral 24-inch diameter cast iron ring and cover.
2. 6 feet – 6 inch by 5 feet – 0 inch (inside dimensions) Chemical Injection Vault with integral aluminum sidewalk door.

B. Precast concrete structures shall be provided with factory applied waterproofing.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges, Division 1 Section 3, Division I Design-Loads (Part A, Part B, Part C).
2. ACI 318, Building Code Requirements for Reinforced Concrete.
3. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A1064/A1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   c. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   d. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   f. C858, Standard Specification for Underground Precast Concrete Utility Structures.
   g. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
4. Design Criteria on General Structural Notes on Drawings.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed Drawings, sections and details showing complete information for arrangement and fabrication including, but not limited to:
      1) Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement details proposed for wall and top slab opening to accommodate pipe, access hatches, etc.
      2) Layout dimensions and identification of each precast unit.
      3) Welded connections indicated by AWS standard symbols.
      4) Details of connections, joints, accessories, and openings or inserts.
      5) Watertight joint details.
      6) Location and details of anchorage devices.
      7) Details/drawings of lifting lug devices proposed for the top slab, riser section, and base slab.
      8) Arrangement drawings depicting access hatch location on top slab.
   b. Product Data:
      1) Precast concrete items; show materials of construction by ASTM reference and grade.
      2) Joint sealants.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Manufacturer’s data for lifting devices for handling and erection.
3. Manufacturer’s certification that vault design and manufacture comply with referenced ASTMs (for example, ASTM C857 and ASTM C858).
4. Vault structural design calculations shall be signed and sealed by a structural engineer registered in the State of Georgia and contain the following at a minimum:
   a. Proposed details and structural design calculations including analysis of stresses in precast concrete members for loading conditions including earth pressures and transportation, handling, and erection.
5. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.

6. Manufacturer's recommended installation instructions.
7. Field quality control report.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Before shipment, all precast concrete structures shall be inspected to determine that materials and workmanship conform to the requirements of these Specifications.

B. Precast structures and sections shall be inspected upon delivery to the jobsite and stored in a manner that will prevent cracking, distortion, warping, straining and other physical damage.

C. Lift and support each unit only at designated lifting points and supporting points as shown on Shop Drawings.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 10 years' experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Bartow Precast.
2. Foley Products Company.
3. Oldcastle Precast.
4. "Or-equal" Engineer approved.

2.02 PRECAST CONCRETE STRUCTURES

A. Design Requirements:

1. In the event of a conflict between or among standards, the more stringent standard shall govern.
2. Comply with ASTM C858, except as modified herein.
3. Reinforcing Steel:
   a. Deformed Bars: ASTM A615/A615M, Grade 60.
   b. Welded Wire Fabric: ASTM A1064/A1064M.

4. The precast structures shall have the inside dimensions and minimum thickness of concrete as indicated on the Drawings. Minimum structure wall and slab thickness shall be 6 inches if not indicated otherwise.
5. Construction: Rigid type and behave monolithically. Panel-type vaults/structures are not acceptable.
6. Design Loads: As determined by ASTM C857, and by using Site-specific values listed in General Structural Notes. Design shall accommodate additional stresses or loads that may be imposed during factory precasting, transporting, erection, and placement.
7. Blockouts for all penetrations required to accommodate passing pipes, access hatches, etc., shall be as shown on Contract Drawings.
8. Lifting lugs and blockouts required for the purpose of setting the base, riser and top slab in place at the time of installation. Lifting lugs also required for removing the top slab in the future to replace the flow meter device at the end of its service life.
9. Concrete:
    a. Strength: minimum of 5000 psi compressive strength at 28 days.
    b. Do not use calcium chloride or other salts.
10. Sealant:
    a. Nonswelling preformed joint sealants to provide a lasting, watertight bond.
    b. Manufacturer and Product: Henry Company; RAM-NEK.
    c. “Or-equal” Engineer approved.
11. Mortar: Comply with ASTM C387/C387M, Type S or use non-shrink grout as specified in Section 03 30 10, Structural Concrete.
12. Miscellaneous Connections: All anchors, dowels, bolts, steel welding inserts and connecting plates indicated and/or necessary in connection with the fabrication and erection of precast concrete sections shall be provided. They shall be positioned and shall be held in position rigidly to prevent displacement while concrete is being placed. Off-site welding shall be in accordance with AWS D1.1. No on-site welding is permitted

B. Mark each member or element to indicate location in the structure, top surface, and date of fabrication.

2.03 EXTERIOR COATING

A. Waterproofing shall be as recommended by the structure manufacturer and shall be a black bituminous compound of brush or spray consistency for application on below grade concrete surfaces.

2.04 ACCESSORIES

A. Cast-in lightweight cast iron ring/frame and cover as shown on Drawings.

B. Sidewalk Doors: As specified in Section 05 50 00, Metal Fabrication and shown on Drawings.

C. Lifting Lugs: Manufactured from Type 316 stainless steel suitably sized to accommodate lifting of each vault structural component with an appropriate factor of safety. Lugs for top slab to be designed for installation in recessed blockouts at four corners of the slab.

PART 3 EXECUTION

3.01 GENERAL

A. Possible Settlement: If subgrade is encountered that may require removal to prevent structure settlement, notify Engineer. Engineer will determine depth of over excavation and means of stabilizing subgrade prior to structure installation.

B. Place on native and undisturbed earth; thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Articles Excavation and Fill and Backfill.

3.02 EXCAVATION AND BACKFILL

A. Remove and keep water clear from excavation during construction.

B. Excavation: As specified in Section 31 23 16, Excavation.

C. Backfill: As specified in Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.

3.03 INSTALLATION

A. Concrete Base:

1. Place on prepared subgrade. If a cast in place base is proposed, provide suitable formwork for the concrete pour.
2. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Carefully inspect precast sections to be joined.
2. Thoroughly clean ends of sections to be joined.
3. Do not use sections with chips or cracks.

C. Joints:

1. Fill joints between precast sections per manufacturer’s recommendation.
2. Joints shall be watertight to prevent entrance of groundwater.
3. Joint Finish: Dry pack interior of joints to provide smooth finish.

D. Setting Precast Structure: Install structure to elevations shown on the Contract Drawings. Finish grade of structure top shall be even with surrounding finish grade surface, unless noted otherwise on the Contract Drawings.

E. No open cracks or spalls. Cracking and defective areas of concrete shall be repaired per requirements of Section 03 30 10, Structural Concrete.

3.04 PIPE CONNECTION TO VAULT

A. Grout pipe connections flush with interior and exterior walls.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
2. ASTM International (ASTM): E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
3. International Code Council (ICC):
4. International Building Code (IBC).
5. International Mechanical Code (IMC).
6. Manufacturers' Standardization Society (MSS): SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Calculations for each type of pipe support, attachment and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
5. Electrical Conduit Support: Include in design of framing support system.

C. 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.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

2.02 SUPPORT MATERIAL

A. Fiberglass Reinforced Plastic (FRP):

1. To include UV additive, protective veil, and vinyl ester resins resistance to chemical stored and fed as part of this project.
2. Fire Retardant: ASTM E84.
3. Include hangers, rods, attachments, and fasteners.

2.03 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-1/2-inch wide minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:

1. Unistrut.
2. Aickinstrut.
3. Enduro-Durostrut.

2.04 FRP PIPE SUPPORTS SYSTEMS

A. Clevis Hangers:

1. Factor of Safety: 3 to 1.
2. Minimum Design Load: 200 pounds.

B. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight non-FRP fasteners or components in Shop Drawing and provide confirmation of chemical compatibility.

C. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.05 ACCESSORIES

A. Anchor Bolts:

1. Size and Material: As specified in Section 05 50 00, Metal Fabrications.
2. Bolt Length (Extension Above Top of Nut):
   a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
   b. Maximum Length: No more than a full nut depth above top of nut.

B. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

C. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

D. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
   a. Anvil; Figure 47, Figure 49, or Figure 52.
   b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.

3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Insulated Pipe:

1. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
2. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
3. Wall-mounted pipe clips not acceptable for insulated piping.

C. Standard Attachments:

1. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
2. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

END OF SECTION

SECTION 40 05 33
PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Process Piping—General, and shall include a 10 percent safety factor.
2. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.

B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.

C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).

D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).

E. Service Voltage: As indicated by branch circuits provided for heat tracing on the Drawings.

F. Manufacturers and Products:

1. Raychem; BTV-CR.
2. Thermon; BSX.
3. Nelson; CL1-J1 or L1-J1.

2.03 CONNECTION SYSTEM

A. Rating: NEMA 250, Type 4 and Factory Mutual approved.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

C. Manufacturers and Products:

1. Power Connection Kit:
   a. Raychem; JBS-100.
   b. Thermon; PCA-1-SR or DP-L.
   c. Nelson; PLT-BC.
2. Splice Kit:
   a. Raychem; S-150.
   b. Thermon; PCS-1-SR.
   c. Nelson; PLT-BS.
3. Tee Kit:
   a. Raychem; T-100.
   b. Thermon; DS-S.
   c. Nelson; PLT-BY.
4. End Seal Kit:
   a. Raychem; E-150.
   b. Thermon; DE-S.
   c. Nelson; LT-ME.
5. Lighted End Seal Kit:
   a. Raychem; E-100-L.
   b. Thermon; DLS.
   c. Nelson; LT-L.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
   a. Raychem; AT-180.
   b. Thermon; AL-20P.
   c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
   a. Raychem; GS54 or GT66.
   b. Thermon; PF-1.
   c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

A. Type: Fixed, nonadjustable, set at 40 degrees F.

B. Sensor: Fluid-filled with 3-foot capillary.

C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.

D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-F5.
2. Thermon; E4X-1.
3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

A. Type: Adjustable setting (15 to 140 degrees F).

B. Sensor: Fluid-filled probe.

C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.

D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.

E. Manufacturers and Products:

1. Raychem; DigiTrace Model AMC-1A.
2. Thermon; B4X-15140.
3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Install on all outside, exposed piping with the exception of:
   a. ACH fill line.
   b. Tank drain used for draining exterior containment space.
   c. OF piping.
   d. V piping.
2. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
3. Where design heating load exceeds heating tape capacity, install by spiraling.
4. Derate heating tape capacity when installed on plastic piping.

5. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit. Provide multiple 20-amp circuits as required at individual heat tracing locations.

D. Thermostats:

1. Install in accordance with manufacturer's instructions and as approved by Engineer.
2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   b. B31.1, Power Piping.
   c. B31.3, Process Piping.
   d. B31.9, Building Services Piping.
2. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   d. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   e. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   f. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   g. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   h. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   i. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   j. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   k. F436, Standard Specification for Hardened Steel Washers.
   l. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   m. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

n. F441/F441M, Standard Specification for Chlorinated Poly (Vinyl-Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
o. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
p. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
q. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

3. NSF International (NSF):
   a. ANSI 61: Drinking Water System Components - Health Effects.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
4. Thrust Restraints:
   a. Design for test pressure shown in Piping Schedule.
   b. Allowable Soil Pressure: 1,000 pounds per square foot.
   c. Low Pressure Pipelines:
      1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
      2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.03 SUBMITTALS

A. Action Submittals: Product information sufficient to determine it meets this Specification (including attached supplements).

B. Informational Submittals:

1. Flanged Pipe and Fittings: Manufacturer’s product data sheets for gaskets including torqueing requirements and bolt tightening procedures.
2. Solvent welding of Double Wall Containment Piping qualifications.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Solvent Welder For Double Wall Containment Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:

1. Standardized Products: Nominal size.

2.03 JOINTS

A. Flanged Joints: Suitable for use in conjunction with polyethylene tank connection.

B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "Or-equal" will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

3.03 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
6. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

F. Polyethylene Tubing:

1. For tubing fed through Containment (CONT) piping, terminate the length tubing in chemical manhole and connect to a new length within the manhole.

3.04 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch(es) from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.05 INSTALLATION—BURIED PIPE

A. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.

7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    a. Shorter pipe lengths.
    b. Special mitered joints.
    c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

B. PVC and CPVC Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

C. Tolerances:

1. Deflection from Horizontal Line, Except PVC, or CPVC: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch(es).
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.06 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on the Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on the Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.07 INSTALLATION—DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. Install according to manufacturer's instructions.

B. Valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.

C. Centering Devices for Double Wall Containment Piping: Center and support carrier pipe within the containment pipe with centering devices. Locate not less than every 9 feet, or within 24 inches of the termination of containment pipe on fabricated pieces.

D. Following Installation and Testing:

1. Flush clean carrier and containment piping system.
2. Purge annular space of moisture with clean, dry air.

3.08 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.09 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.10 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.11 HEAT TRACING

A. See Section 40 05 33, Pipe Heat Tracing.

3.12 PIPE IDENTIFICATION

A. As specified in Section 10 14 00, Signage.

3.13 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

3.14 CLEANING

A. Following assembly and testing, and prior to final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.15 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Piping Schedule Legend.
2. Piping Schedule.
3. Data Sheets.

Number	Title
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
40 27 00.15	Double Wall Containment Piping
40 27 00.19	Polyethylene Tubing

END OF SECTION

PIPING SCHEDULE LEGEND

SERVICE

ACH	Aluminum Chlorohydrate
CONT	Containment Pipe
HW	Hot Water
OF	Overflow
PD	Process Drain
TW	Tempered Water
V	Vent
W1	Water-Potable
W2	Water-Backflow Prevented Water

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

CPVC	Chlorinated PVC
DWC	Double Wall Containment
PE	Polyethylene
PVC	Polyvinyl Chloride

JOINT TYPE

FL	Flanged
GR	Grooved
PRJ	Proprietary Restrained
RM	Restrained Mechanical
TH	Threaded
W	Welded (including solvent and fusion)

PRESSURE TEST TYPE

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service
P	Pneumatic
PC	Test per Uniform Plumbing Code
NA	Not Applicable

Piping Schedule							
Service ID	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Test Pressure-Type (psig-Type)**	**Remarks**
ACH	ALL	EXP	DWC	40 27 00.15	W, FL	15-H	See Drawings for clarification on what is used where. Flanged only at connection to tank
	ALL	EXP	PVC	40 27 00.10	W	15-H (upstream of pump) 50-H (downstream of pump)	
	ALL	EXP BUR ENC	PE	40 27 00.19	W	50-H	
CONT	ALL	EXP BUR ENC	PVC	40 27 00.10	W	10-H	
HW	ALL	EXP	CPVC	40 27 00.11	W	150-H	
OF	ALL	EXP	PVC	40 27 00.10	W	None	
PD	ALL	EXP BUR ENC	PVC	40 27 00.10	W	G	
TW	ALL	EXP	CPVC	40 27 00.11	W	150-H	
V	ALL	EXP	PVC	40 27 00.10	W	None	
W1	ALL	BUR EXP	CPVC	40 27 00.11	W	150-H	
W2	ALL	EXP	CPVC	40 27 00.11	W	150-H	

[1]">" Greater Than
"<" Less Than
"<=" Less Than or Equal To
">=" Greater Than or Equal To
"All" All Sizes
For Double Wall Containment Pipe, this size is the interior Carrier pipe size.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick Durlon, 9200W RCA, Garlock Gylon 3510. Raised Face Mating Flange: Flat ring 1/8-inch Durlon, 9200W RCA, Garlock Gylon 3510, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441/F441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Solvent Cement	All	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 00.15 DOUBLE WALL CONTAINMENT PIPING	
Item	**Description**
Carrier Pipe	Polyvinyl Chloride (PVC): Schedule 80 and shall be manufactured from a Class 12454-B PVC resin, according to ASTM D1784. Joints shall be solvent-welded socket type. Supply straight sections in 20-foot random lengths.
Containment Pipe	Polyvinyl Chloride (PVC): Schedule 80, in accordance with ASTM D1784.
Guides	Provided of the same resin as the product pipe.
Flanges	One-piece, molded hub type PVC flat face flange, ASME B16.1, Class 125 drilling
Bolting	ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	Flat Face Mating Flange: Full faced 1/8-inch thick Durlon, 9200W RCA, Garlock Gylon 3510. Raised Face Mating Flange: Flat ring 1/8-inch Durlon, 9200W RCA, Garlock Gylon 3510, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.

END OF SECTION

SECTION 40 27 00.19 POLYETHYLENE TUBING		
Item	**Size**	**Description**
Tubing	All	Minimum wall thickness of 1/16-inch, minimum working pressure 90 psi at 73 degrees F. Conform to ASTM D-1248, Type 1, Class A. Minimum bend radius of 4 inches or less.
Fittings	All	To be made of PVC, CPVC, PTFE, PE, Hastelloy-C276, or HDPE. Pressure rating of fittings to meet or exceed that of the tubing.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

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

1. D1784, Standard Classification system and Basis for Specification for Rigid PVC Compounds and CPVC Compounds.
2. D1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.

2.02 CONNECTORS

A. Quick Disconnect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male, locking, for chemical loading and transfer.
2. Materials: Polypropylene with Teflon gaskets.
3. Plugs and Caps: Female dust cap.
4. Pressure Rating: 100 psi, minimum, at 70 degrees F.

5. Manufacturers and Products:
    a. Camlock.
    b. Ryan Herco.
    c. Evertite.

2.03 PVC FLOOR PENETRATION:

A. PVC Water Stop Flanges:

1. Schedule 80 PVC in accordance with ASTM D1784/D1785.
2. PVC flange to be Type 1 with a minimum thickness, thermally fused circumferentially to the outside of the PVC pipe using Type 1 welding rod.
3. Manufacturer:
    a. Aqua Logic Water.
    b. Engineer Approved Equal.

2.04 MISCELLANEOUS SPECIALTIES

A. Strainers, Plastic Piping Systems, 4 Inches and Smaller:

1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Teflon seals.
2. End Connections: Solvent weld, true union.
3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturer: Hayward.

2.05 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. See Drawings for additional details and requirements.
2. Manufacturer to provide.
3. Injector:
    a. Retractable quill.
    b. Integral check valve included.
    c. High corrosion resistance model with Hastelloy isolation and ball check valve, 1/2 inch Hastelloy solution tube, and FKM seals.
    d. Make/Model: SAF-T-FLO/HC-100.
4. Flexible Hose Assembly:
    a. HDPE tubing with threaded coupler end connection.
    b. Includes PVC ball valve inlet.
    c. FKM seals.
    d. Make/Model: SAF-T-FLO/FTA series.

B. Support System:

1. FRP Channel support.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: In accordance with manufacturer requirements.

PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

B. Install in accordance with manufacturer requirements

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
2. Tests and inspection data.

PART 2 PRODUCTS

2.01 GENERAL

A. See Division 22, Plumbing Specifications for plumbing valve details.

B. For valves provided as part of the chemical pump skid, see Section 44 44 13.01, Chemical Metering Pumps for details.

C. Valves to include operator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

D. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

E. Valve same size as adjoining pipe, unless otherwise called out on the Drawings or in Supplements.

F. Valve ends to suit adjacent piping.

G. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

H. Size operators to operate valve for full range of pressures and velocities.

I. Valve to open by turning counterclockwise, unless otherwise specified.

J. Factory mount operator, actuator, and accessories.

2.02 VALVES

A. Ball Valves:

1. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Teflon O-ring stem seals, to block flow in both directions.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.
2. Type V332 Double Contained PVC Ball Valve:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Teflon O-ring stem seals, to block flow in both directions.
   b. Suitable for use with the schedule of pipe specified in Section 40 27 00.15, Double Wall Containment Piping Data Sheet
   c. Manufacturers and products: Provide double wall containment pipe manufacturer’s corresponding ball valve.

2.03 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.
3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

B. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer's recommendations.
2. Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

C. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

D. Set, verify, and record set pressures for relief and regulating valves.

E. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

END OF SECTION

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
   b. C547, Standard Specification for Mineral Fiber Pipe Insulation.
   c. C552, Standard Specification for Cellular Glass Thermal Insulation.
   d. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
   e. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   g. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. UL.

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.

2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
6. Flame Spread Rating: Less than 25 per ASTM E84.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

B. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer’s recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 INSULATION AT PIPE SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
   a. Knauf Insulation; Proto 1000.
   b. Johns Manville; Zeston 2000 or 300.
   c. Speedline; 25/50 Smoke-Safe.

B. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
2. Type 3 Insulation—Greater that 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section”.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.

2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

B. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

C. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

D. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

E. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.04 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this Specification:

1. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness					
			Finish Systems		
Service Type	**Insulation Thickness (inches*)**	**Insulation**	**Indoors Exposed**	**Outdoors**	**Buried**
HT–Piping requiring heat tracing (See 40 05 33, Pipe Heat Tracing)	Pipe Size/ Insulation Thickness 0.25-3/ 1 3.5-10/ 1.5 12-16/ 2 18-24/ 2.5	Outside lines 1' above grade-Type 2 From 1' above grade to frost depth-Type 3	F1	F1	F4 on Type 3
Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness.					

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information required by the test report.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. New Piping Connected to Existing Piping:
    a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
    b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Items that do not require testing include:
    a. Tank overflows.
    b. Tank atmospheric vents.
6. Test Pressure: As indicated on Piping Schedule.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure. Increase test time as needed to ensure the leak test measurement method has enough time render an meaningful output (Example: If the level of a large storge volume is the basis for calculating leakage, instrument sensitivity may require a long time to register a change due to a leakage value outside of allowable leakage).
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

6. Maximum Allowable Leakage:

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

where:

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

7. Correct leakage greater than allowable, and retest as specified.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

D. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

F. Defective Piping Sections: Replace, and retest as specified.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test type
5. Test pressure.
6. Method of isolation
7. Calculation of maximum allowable leakage and the corresponding result of the test demonstrating a passed test.
8. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
9. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 01
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
2. International Society of Automation (ISA):
   a. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
   b. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
   c. S5.4, Standard Instrument Loop Diagrams.
   d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, General Standards for Industrial Control and Systems.
4. National Institute of Standards and Technology (NIST).
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
6. UL: 508A, Standard for Safety, Industrial Control Panels.

1.02 SUMMARY

A. Work Includes:

1. Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete Process Instrumentation and Control (PIC) for plant.
2. Major parts are:
   a. Primary elements, transmitters, control devices and control panels.
   b. Addition of the following new PLC RTU and Control Panel.
      1) 210RTU, located near the new LOX and Ferric Chloride facility. This will connect to the PLC/SCADA system in the Land Management Building via Cellular Modem.
      2) 210FP located near the new ACH Storage Tank. This will monitor level in the storage tank and alarm at high level. The level signal and high high level alarm will be retransmitted to 210RTU.
   c. Integration of new systems and controls into existing iFIX HMI system at the Land Management Building. Create displays as required for the process equipment as depicted on the Contract Drawings. Modify existing graphics as required. Contractor shall follow the existing graphics standards to provide consistent look and feel.
   d. Application software configuration shall be provided by the owner selected integrator, MR Systems. Work includes but is not limited to, programming of the existing RTU, modifications to the existing PLC(s) as required, configuration of the existing servers and PLC networks and additions/ modifications to the iFIX application software.

B. Detailed Design: PIC as shown and specified includes functional and performance requirements and component specifications. Complete detailed PIC design.

C. PIC System Integrator has been pre-selected by the Owner: MR Systems, Norcross, GA.

1.03 DEFINITIONS

A. Abbreviations:

1. CP: Control Panel.
2. FP: Field Panel.
3. HMI: Human Machine Interface.
4. LCP: Local Control Panel.
5. MCC: Motor Control Center.

6. PAT: Performance Acceptance Test.
7. PIC: Process Instrumentation and Control.
8. PLC: Programmable Logic Controller.
9. RTU: Remote Telemetry Unit.

B. Rising/Falling: Terms used to define actions of discrete devices about their setpoints.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

C. Signal Types:

1. Analog Signals, Current Type:
   a. 4 mA to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC Subsystem components, use the following ISA 50.1 options:
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signals, Voltage Type: 1 to 5 volts dc within panels where a common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid-state switches as indicated.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

D. Instrument Tag Numbers:

1. A shorthand tag number notation is used in the Loop Specifications. For example: 102AIT1-(3)[pH].

Notation	Explanation
10	Unit process number.
2	Loop number.
AIT	ISA designator for Analysis Indicating Transmitter.

Notation	Explanation
(3)	First unit number; number of same 102-1 component types in a given loop; -1 and -2 in this example.

2. In this example, 102AIT-(3) is shorthand for: 102AIT1; 102AIT2; 102AIT3.

1.04 SUBMITTALS

A. Action Submittals:

1. General:
   a. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
   b. Identify proposed items and options. Identify installed spares and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
   c. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (for example, engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).
2. Bill of Materials: List of required equipment.
   a. Group equipment items as follows:
      1) I&C Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number, and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
3. Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:
   a. Catalog information, mark to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
4. Component Data Sheets: Data sheets for I&C components.
   a. Format and Level of Detail: In accordance with ISA-S20.
   b. Include component type identification code and tag number on data sheet.

c. Specific features and configuration data for each component:
   1) Location or service.
   2) Manufacturer and complete model number.
   3) Size and scale range.
   4) Setpoints.
   5) Materials of construction.
   6) Options included.
d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

5. Sizing and Selection Calculations:
   a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.
   b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
6. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
   b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
7. Panel Control Diagrams: For discrete control and power circuits.
   a. Diagram Type: Ladder diagrams. Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
   b. Item Identification: Identify each item with attributes listed.
      1) Wires: Wire number and color. Cable number if part of multiconductor cable.
      2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
      3) Discrete Components:
         a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).

b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).

4) Relay Coils:
   a) Tag number and its function.
   b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

c. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be permitted.
d. Ground wires, surge protectors, and connections.
e. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.

8. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.
9. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
   a. Conform to the minimum requirements of ISA S5.4.
   b. Under Paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2 and 6.
   c. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
   d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
   e. Show:
      1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
      2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
      3) Tabular summary on each diagram:
         a) Transmitting Instruments: Output capability.
         b) Receiving Instruments: Input impedance.
         c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
         d) Total loop impedance.
         e) Reserve output capacity.
      4) Circuit and raceway schedule names.
10. Interconnecting Wiring Diagrams:
    a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.

b. Diagrams shall bear electrical Subcontractor's signature attesting diagrams have been coordinated with Division 26, Electrical.
c. Show:
1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
2) Component and panel terminal board identification numbers, and external wire and cable numbers.
3) Circuit names matching Circuit and Raceway Schedule.
4) Intermediate terminations between field elements and panels (for example, to terminal junction boxes and pull boxes).
5) Pull boxes.

11. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
12. List of spares, expendables, test equipment and tools.
13. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended. Include unit prices and total costs as specified.

B. Informational Submittals: For PIC equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.

1. Owner Training Plan. Reference Section 01 43 33, Manufacturers' Field Services.
2. Operation and Maintenance (O&M) Manuals: In accordance with Division 01, General Requirements, unless otherwise specified in this section.
a. Content and Format:
1) Complete sets O&M manuals.
2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
3) Final versions of Legend and Abbreviation Lists.
4) Manual format in accordance with Division 01, General Requirements.
b. Include:
1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PIC design.
2) Refer to paragraph Shop Drawings for the following items:
a) Bill of Materials.
b) Catalog Cuts.
c) Component Data Sheets.
d) Panel Control Diagrams.
e) Panel Wiring Diagrams, one reproducible copy.
f) Panel Plumbing Diagrams, one reproducible copy.
g) Loop Diagrams, one reproducible copy.

h) Interconnecting Wiring Diagrams, one reproducible copy.
i) Application Software Documentation.

3) Device O&M manuals for components, electrical devices, and mechanical devices include:
a) Operations procedures.
b) Installation requirements and procedures.
c) Maintenance requirements and procedures.
d) Troubleshooting procedures.
e) Calibration procedures.
f) Internal schematic and wiring diagrams.
g) Component Calibration Sheets from field quality control calibrations.

4) List of spares, expendables, test equipment and tools provided.
5) List of additional spares, expendables, test equipment and tools recommended.

3. Performance Acceptance Tests (PAT) Submittals:
a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
b. Final Test Procedures: Proposed test procedures, forms, and checklists.
c. Test Documentation: Copy of signed off test procedures when tests are completed.
4. Manufacturer’s statement that installer is certified to perform installation Work for fiber optic cables.
5. Operation and Maintenance Data: As specified in Division 01, General Requirements.

1.05 QUALITY ASSURANCE

A. Calibration Instruments: Each instrument used for calibrating PIC equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.

B. Coordination Meetings:

1. Location: Owner’s Site.
2. Attended By: Engineer, Owner, and Contractor.
3. Minimum of one is required. Specific dates will be established in Progress Schedule.
4. First Meeting: Within 36 days after Notice to Proceed.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide Site and warehouse storage facilities for PIC equipment.

B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Standard Environmental Requirements: Unless otherwise noted, design equipment for continuous operation in these environments:

1. Freestanding Panel and Consoles:
   a. Inside, Air Conditioned: NEMA 1.
   b. Inside: NEMA 12.
   c. Outside: NEMA 4X.
2. Smaller Panels and Assemblies (that are not Freestanding):
   a. Inside, Air Conditioned: NEMA 12.
   b. All Other Locations: NEMA 4X.
3. Field Elements: Outside.

B. Environmental Design Requirements: Following defines the types of environments referred to in the above.

1. Inside, Air Conditioned:
   a. Temperature:
      1) Normal: 60 to 80 degrees F.
      2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
   b. Relative Humidity:
      1) Normal: 10 percent (winter) to 70 percent (summer).
      2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
   c. NEC Classification: Nonhazardous.
2. Inside:
   a. Temperature: 20 to 104 degrees F.
   b. Relative Humidity: 10 to 95 percent noncondensing.
   c. NEC Classification: Nonhazardous.
3. Inside, Corrosive:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 10 to 95 percent noncondensing.
   c. Corrosive Environment: Aluminum Chlorohydrate Gas.
   d. NEC Classification: Nonhazardous.

4. Outside:
    a. Temperature: Minus 20 to 104 degrees F.
    b. Relative Humidity: 10 to 95 percent noncondensing, freezing rain.
    c. NEC Classification: Nonhazardous.
5. Outside, Corrosive:
    a. Temperature: Minus 20 to 104 degrees F.
    b. Relative Humidity: 10 to 95 percent noncondensing, freezing rain.
    c. Corrosive Environment: Chlorine gas.
    d. NEC Classification: Nonhazardous.

C. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

1.08 SEQUENCING AND SCHEDULING

A. Activity Completion: The following is a list of key activities and their completion criteria:

1. Shop Drawings: Reviewed and approved.
2. Quality Control Submittals: Reviewed and accepted.
3. Hardware Delivery: Hardware delivered to Site and inventoried by Contractor.
4. PAT: Completed and required test documentation accepted.

B. PIC Substantial Completion: When Engineer issues Certificate of Substantial Completion.

1. Prerequisites:
    a. All PIC Submittals have been completed.
    b. PIC has successfully completed PAT.
    c. Owner training plan is on schedule.
    d. All spares, expendables, and test equipment have been delivered to Owner.

C. PIC Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.

1. Prerequisites:
    a. Certificate of Substantial Completion issued for PIC.
    b. Punch-list items completed.
    c. Final revisions to O&M manuals accepted.
    d. Maintenance service agreements for PIC accepted by Owner.

D. Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer	Engineer acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly	Associated Shop Drawing Submittals completed.
Shipment	Completion of PIC Shop Drawing Submittals and preliminary O&M manuals.
Owner Training	Owner training plan completed.
PAT	Startup, Owner training, and PAT procedures completed; notice 4 weeks prior to start.

PART 2 PRODUCTS

2.01 GENERAL

A. PIC functions as shown on the Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.

B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment and materials.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.
2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 LOOP SPECIFICATIONS

A. Location: Article Supplements.

B. Organization: By unit process and loop number.

C. Functional Requirements for Control Loops:

1. Shown on the Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.
2. Supplemented by Loop Specifications.

D. Subheadings for Each Loop:

1. Functions: Clarifies functional performance of loop, including abstract of interlocks.
    a. Components: Lists major components for each loop. Information listed includes tag numbers.
    b. Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article Supplements.
    c. Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, setpoints, and controller options.

2.03 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch white on black background, unless otherwise noted.

B. Component Nameplates—Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 3/16-inch white on black background, unless otherwise noted.

C. Component Nameplates—Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 3/16-inch white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:

1. Inscription, refer to:
   a. Table under paragraph Standard Pushbutton Colors and Inscriptions.
   b. Table under paragraph Standard Light Colors and Inscriptions.
   c. P&IDs in the Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 3/16-inch white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch imposed.
4. Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.04 ELECTRICAL REQUIREMENTS

A. In accordance with Division 26, Electrical.

B. I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.

C. Wires Within Enclosures:

1. ac Circuits:
   a. Type: 300-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 18 AWG.
2. Analog Signal Circuits:
   a. Type: 300-volt stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 300-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than 18 AWG.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

D. Wires entering or leaving enclosures, terminate and identify as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals, terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with Division 26, Electrical.

E. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC and RTU I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for 18-WG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.
2. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal groves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   c. Screws: Hardened steel, captive and self-locking.
   d. Current Bar: Copper or treated brass.

e. Insulation:
   1) Thermoplastic rated for minus 55 to plus 110 degree C.
   2) Two funneled shaped inputs to facilitate wire entry.
f. Mounting:
   1) Standard DIN rail.
   2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
   3) End Stops: Minimum of one at each end of rail.
g. Wire preparation: Stripping only permitted.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
   1) Terminal number shown on both sides of terminal block
   2) Allow use of preprinted and field marked tags.
   3) Terminal strip numbers shown on end stops.
   4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
   5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

3. Terminal Block, General-Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30 amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Grey body.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Weidmuller.
4. Terminal Block, Ground:
   a. Wire Size: 22 AWG to 12 AWG.
   b. Rated Wire Size: 12 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
   f. Manufacturer and Product: Weidmuller.
5. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 16-amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Grey body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512 inch, maximum.
   i. Manufacturer and Product: Weidmuller.

6. Terminal Block, Fused, 120V ac:
    a. Rated Voltage: 600V ac.
    b. Rated Current: 16-amp.
    c. Wire Size: 22 AWG to 10 AWG.
    d. Rated Wire Size: 10 AWG.
    e. Color: Grey body.
    f. Fuse: 0.25 inch by 1.25 inches.
    g. Indication: Neon Lamp 110V ac.
    h. Leakage Current: 1.8 mA, maximum.
    i. Spacing: 0.512 inch, maximum
    j. Manufacturer and Product: Weidmuller.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
    a. Locate at dc power supply for loop.
    b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.

H. Power Distribution Within Panels:

1. Feeder Circuits:
    a. One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
    b. Make provisions for feeder circuit conduit entry.
    c. Furnish terminal board for termination of wires.
2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
    a. Locate to provide clear view of and access to breakers when door is open.
    b. Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
        1) Branch Circuit Breaker: 15 amps at 250V ac.
    c. Breaker Manufacturers and Products: Refer to Division 26, Electrical.

3. Circuit Wiring: P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
   a. Devices on Single Circuit: 20, maximum.
   b. Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
   c. Branch Circuit Loading: 12 amperes continuous, maximum.
   d. Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
   e. Provide 120V ac plugmold for panel components with line cords.

I. Signal Distribution:

1. Within Panels: 4 mA to 20 mA dc signals may be distributed as 1 to 5V dc.
2. Outside Panels: Isolated 4 mA to 20 mA dc only.
3. All signal wiring twisted in shielded pairs.

J. Relays:

1. General:
   a. Relay Mounting: Plug-in type socket.
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.
2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Idec.
3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general-purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).

g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Push to test button.
k. Manufacturer and Product: Idec.

K. Power Supplies:

1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1 in accordance with NEMA 250.
5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.

L. Internal Panel Lights for Freestanding Panels:

1. Type: Switched LED back-of-panel lights.
2. Quantity: One light for every 4 feet of panel width.
3. Mounting: Inside and in the top of back-of-panel area.
4. Protective metal shield for lights.

M. Service Outlets for Freestanding Panels:

1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
2. Quantity:
   a. For panels 4 feet wide and smaller: One.
   b. For panels wider than 4 feet: One for every 4 feet of panel width, two minimum per panel.
3. Mounting: Evenly spaced along back-of-panel area.

N. Internal Panel Lights and Service Outlets for Smaller Panels:

1. Internal Panel Light: Switched LED light.
2. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
3. Required for all following panels: 210RTU.

O. Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted on the Drawings.

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

1. Lettering Color:
   a. Black on white and yellow buttons.
   b. White on black, red, and green buttons.

P. Standard Light Colors and Inscriptions: Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted on the Drawings.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White

Tag Function	Inscription(s)	Color
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

1. Lettering Color:
   a. Black on white and amber lenses.
   b. White on red and green lenses.

2.05 SPARE PARTS

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	**2**
Fuses	20	**5**
Indicating light bulb	20	**10**
Relays	20	**3**
Terminal Blocks	10	**10**
Hand Switches	10	**5**

2.06 FABRICATION

A. General:

1. Panels with external dimensions and instruments arrangement as shown on the Drawings or in Control Panel List.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments, wire, and plumb, at the PIC factory.
4. Electrical Work: In accordance with Division 26, Electrical.

B. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.

C. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

D. Wiring Within PIC Panels:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
    a. Locking-fork-tongue or ring-tongue lugs.
    b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
    c. Wires terminated in a crimp lug, maximum of one.
    d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
    a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
    b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

E. Temperature Control:

1. Provide Heat Load Calculations for all control panels.
2. Freestanding Panels:
    a. Non-ventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
    b. Ventilated Panels:
        1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
        2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
        3) For panels without backs against wall, furnish louvers on top and bottom of panel back.

4) Louver Construction: Stamped sheet metal.
5) Ventilation Fans:
   a) Furnish where required to provide adequate cooling.
   b) Create positive internal pressure within panel.
   c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
6) Air Filters: Washable aluminum, Hoffman Series A-FLT.

3. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
4. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dew point.
   b. Required for following panels: All.

F. Freestanding Panel Construction:

1. Materials: Sheet steel, unless otherwise shown on the Drawings with minimum thickness of 10-gauge, unless otherwise noted.
2. Panel Fronts:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.
   d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
   a. Structural steel for instrument support and panel bracing.
   b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Doors: Full height, fully gasketed access doors where shown on the Drawings.
   a. Latches: Three-point, Southco Type 44.
   b. Handles: “D” ring, foldable type.
   c. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
   d. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
   e. Front and Side Access Doors: As shown on the Drawings.

G. Non-freestanding Panel Construction:

1. Based on environmental design requirements required and referenced in Article Environmental Requirements, provide the following:
   a. For panels listed as inside, air conditioned:
      1) Enclosure Type: NEMA 12 in accordance with NEMA 250.
      2) Materials: Steel.
   b. For all other panels:
      1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
      2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.
4. Manufacturers:
   a. Hoffman Engineering Co.
   b. Rittal.

H. Factory Finishing:

1. Enclosures:
   a. Stainless Steel and Aluminum: Not painted.
   b. Nonmetallic Panels: Not painted.
   c. Steel Panels:
      1) Sand panel and remove mill scale, rust, grease, and oil.
      2) Fill imperfections and sand smooth.
      3) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
      4) Sand surfaces lightly between coats.
      5) Dry Film Thickness: 3 mils, minimum.
2. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

2.07 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.

2.08 SOURCE QUALITY CONTROL

A. Scope: Inspect and test entire PIC to ensure it is ready for shipment, installation, and operation.

B. Location: Manufacturer’s factory or Engineer approved staging Site.

C. Test: Exercise and test all functions.

D. Temporary PLC software configuring to allow PLC testing.

2.09 ELECTRICAL TRANSIENT PROTECTION

A. General:

1. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
   a. Connection of ac power to PIC equipment including panels, consoles assembles, and field mounted analog transmitters and receivers.
   b. At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac. All other applications: 30 amps minimum at 130V ac.

C. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8 microsecond rise in current form 0 amps to a peak current value followed by an exponential decay of current reaching one half the peak value in 20 microseconds.

2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
    a. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
    b. dc Clamping Voltage Tolerance: Less than plus or minus 10 percent.
    c. Maximum Loop Resistance: 18 ohms per conductor.

D. Physical Characteristics:

1. Mounted in Enclosures: Encapsulated inflame retardant epoxy.
2. For Analog Signals Lines: EDCO PC-642 or SRA-64 series.
3. For 120V ac Lines: EDCO HSP-121.
4. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
    a. Enclosure: NEMA 4X fiberglass or Type 316 stainless steel with door.
        1) Maximum Size: 12 inches by 12 inches by 8 inches deep.
    b. Manufacturer and Product: EDCO; SLAC series.

E. Installation and Grounding of Suppressors: As shown. See Surge Suppressor Installation Details. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC, but that directly interfaces with the PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.
4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Retain a copy of manufacturers' instructions at Site, available for review at all times.

B. Electrical Wiring: As specified in Division 26, Electrical.

C. Mechanical Systems:

1. Drawings for PIC Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
2. Copper and Stainless Steel Tubing Support: Continuously supported by an aluminum tubing raceway system.
3. Plastic Tubing Supports: Except as shown on the Drawings, provide continuous support in conduits or by aluminum tubing raceway system.
4. Install tubing conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
5. Tubing and Conduit Bends:
    a. Tool-formed without flattening, and all of same radius.
    b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
    c. Slope instrument connection tubing in accordance with installation details.
    d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
    e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
    f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
    g. Blow debris from inside of tubing.
    h. Make up and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
    i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
    j. Run tubing to allow, for example, clear access to doors, controls, and control panels; and to allow for easy removal of equipment.
    k. Provide separate support for components in tubing runs.
    l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
    m. Keep tubing and conduit runs at least 12 inches from hot pipes.
    n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
    o. Securely attach tubing raceways to building structural members.

6. Enclosure Lifting Rings: Remove rings following installation and plug holes.

D. Removal or Relocation of Materials and Equipment:

1. Remove from Site materials that were part of the existing facility but are no longer used, unless otherwise directed by Engineer to deliver to Owner.
2. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

3.03 FIELD QUALITY CONTROL

A. Startup and Testing Team:

1. Thoroughly inspect installation, termination, and adjustment for components and systems.
2. Complete onsite tests.
3. Complete onsite training.
4. Provide startup assistance.

B. Operational Readiness Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PIC is ready for operation.

1. Loop/Component Inspections and Calibrations:
   a. Check PIC for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
   b. Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).
      1) Project name.
      2) Loop number.
      3) Component tag number.
      4) Component code number.
      5) Manufacturer for elements.
      6) Model number/serial number.
      7) Summary of functional requirements, for example:
         a) Indicators and recorders, scale and chart ranges.
         b) Transmitters/converters, input and output ranges.
         c) Computing elements' function.
         d) Controllers, action (direct/reverse) and control modes (PID).
         e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).

8) Calibrations, for example:
   a) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
   b) Discrete Devices: Actual trip points and reset points.
   c) Controllers: Mode settings (PID).
9) Space for comments.

c. These inspections and calibrations will be spot checked by Engineer.

C. Performance Acceptance Tests (PAT): These are the activities associated with Performance Testing.

1. General:
   a. Test all PIC elements to demonstrate that PIC satisfies all requirements.
   b. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect) occurs.
   c. Procedures, Forms, and Checklists:
      1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
      2) Describe each test item to be performed.
      3) Have space after each test item description for sign off by appropriate party after satisfactory completion.
   d. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
   e. Conducting Tests:
      1) Provide special testing materials, equipment, and software.
      2) Wherever possible, perform tests using actual process variables, equipment, and data.
      3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
      4) Define simulation techniques in test procedures.
   f. Coordinate PIC testing with Owner and affected Subcontractors.
      1) Excessive Test Witnessing: Refer to Supplementary Conditions.
2. Test Requirements:
   a. Once facility has been started up and is operating, perform a witnessed PAT on complete PIC to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
   b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

c. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
d. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
e. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.
f. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.04 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner's personnel.
2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
3. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.
4. Owner reserves the right to make and reuse video tapes of training sessions.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
2. Use equipment similar to that provided or currently owned by Owner.
3. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

C. Operations Training:

1. Training Session Duration: One 8-hour instructor days per site.
2. Number of Training Sessions: One per site.
3. Location: Sites.
4. Content: Conduct training on loop-by-loop basis.
   a. Loop Functions: Understanding of loop functions, including interlocks for each loop.

b. Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
c. Interfaces with other control systems.

D. Maintenance Training:

1. Training Session Duration: One 8-hour instructor days per site.
2. Number of Training Sessions: One per site.
3. Location: Project Sites.
4. Content: Provide training for each type of component and function provided.
   a. Loop Functions: Understanding details of each loop and how they function.
   b. Component calibration.
   c. Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
   d. Troubleshooting and diagnosis for components.
   e. Replacing lamps, chart paper, fuses.
   f. Component removal and replacement.
   g. Periodic maintenance.

3.05 CLEANING/ADJUSTING

A. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

B. Cleaning:

1. Prior to closing system using tubing, clear tubing of interior moisture and debris.
2. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. Periodically replace capsules in accordance with capsule manufacturer’s recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.07 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. Instrument and Control Panel List.
2. Loop Specifications.
3. Component Specifications.
4. PLC Input and Output List.
5. Instrument Calibration Sheet: Provides detailed information on each instrument (except simple hand switches, lights, and similar items).
6. I&C Valve Adjustment Sheet: Each sheet shows detailed information for installation, adjustment, and calibration of a given valve.
7. Performance Acceptance Test Sheet: Describes the PAT for a given loop. The format is mostly free form.
   a. Lists the requirements of the loop.
   b. Briefly describes the test.
   c. Cites expected results.
   d. Provides space for check off by witness.

END OF SECTION

INSTRUMENT AND CONTROL PANEL LIST						
Tag Number	**Comp Code**	**Component Title**	**Options**	**P&ID**	**Inst. Detail**	**Panel No.**
210RTU	N/A	RTU	NEMA 4X Type 316SS Max Allowable Dimensions: 4'H x 3'W x 1'D Provide PLC per Component Spec Y555 Provide Hirschmann Spider Managed Ethernet Switch Provide Sierra Wireless Airlink RV50 Cell Modem with Laird M/N: TRA6927M3PW Antenna	08-N-001	4091-402BG	
210FP		ACH Fill Panel	NEMA 4X Type 316 Stainless Steel Max Dimensions: 24"H x 24"W x 12"D	08-N-001	4091-402BG	

LOOP SPECIFICATIONS

Note(s):

1. This document does not describe every function required by the Contract Documents. Rather, it supplements and clarifies the functions required by the P&IDs.
2. The PIC Systems Integrator shall incorporate the new PLCs the new process equipment and functions into the existing plant PLCs and SCADA servers.

OVERVIEW

The PICS System Integrator shall program and configure the following devices:

200RTU4.

PLC-A1 (located at Land Management Building)

HMI graphics and SCADA server databases.

ALARMS

The PICS System Integrator shall display on the computer HMI graphics all alarms shown on the P&IDs and I/O List.

The PICS System Integrator shall also display calculated alarms such as Low Level in each Storage Tank. The PIC System Integrator shall program the PLC to calculate these alarms.

The PIC System Integrator shall store all alarms in data registers.

STATUS MONITORING

The PICS System Integrator shall display on the computer HMI graphics all status signals shown on the P&IDs and I/O List. Examples include ON status of each Aluminum Chorohydrate pump.

The PIC System Integrator shall store all status signals in data registers.

ANALOG DISPLAYS

The PICS System Integrator shall display all analog input variables shown on the P&IDs and I/O List. Examples include storage tank levels.

The PIC System Integrator shall store these analog input variables in data registers.

TRENDS

The PIC System Integrator shall create and display trends of all analog inputs and outputs that are part of this project. This includes field analog inputs and software created analog outputs. Create and display additional trends as noted in these Loop Specifications.

MISCELLANEOUS CONTROL STRATEGIES

Flow Pacing Control:

Provide an analog output to adjust the feed rate of the controlled device; e.g., adjustable speed pump, control valve position.

Analog output is the product of Manual Dosage Adjust and Process Flow Rate. Units of analog output are in percent. Units of Manual Dosage Adjust are in mg/L. Constants used in calculating the product shall be Control Narrative specific. Also include conversion factors to account for a controlled device with non-linear characteristics (such as an equal percentage control valve).

Parameters defined in the specific unit process control narratives include:

- Controlled Device.
- Process Flow Rate.
- Dosage units and substance.

The following equations are provided as a reference for flow pacing:

(When Process Flow is in MGD)

Accept operator Inputs:

Dosage	[mg/l]
Volumetric Pump Capacity	[gal/hr]
Bulk Density	[lbs/gal]
Percent Bulk Strength (= Percent Active Chemical)	[%]

Calculate the active chemical demand flow as follows:

[Demand, Active Chemical] = 0.3477 * [Dosage] * [Process Flow], units as follows:

[Demand, Active Chemical] = [lbs/hr]
[Dosage] = [mg/l]
[Process Flow] = [MGD]

Calculate the active chemical pump capacity at 100% as follows:

[Pump Capacity, Active Chemical] = [Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength/100], units as follows:

[Pump Capacity, Active Chemical] = [lbs/hr]
[Volumetric Pump Capacity] = [gal/hr]
[Bulk Density] = [lbs/gal]

Calculate the pump speed as follows:

[Pump Speed] = 100 * [Demand Flow, Active Chemical]/[Pump Capacity, Active Chemical] = 10,000 * (0.3477 * [Dosage] * [Process Flow])/ ([Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength])

[Pump Speed] = [%]

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40%]
Process Flow	[3 MGD]

[Pump Speed] = 100 * [Demand Flow, Active Chemical]/[Pump Capacity, Active Chemical] = 10,000 * (0.3477 * [2 mg/l] * [3 MGD])/ ([20 gal/hr] * [11.93 lbs/gal] * [40])

[Pump Speed] = 2.19 %

(When Process Flow is in gpm)

Accept operator Inputs:

Dosage	[mg/l]
Volumetric Pump Capacity	[gal/hr]
Bulk Density	[lbs/gal]
Percent Bulk Strength (=Percent Active Chemical)	[%]

Calculate the active chemical demand flow as follows:

[Demand Flow, Active Chemical] = 5.007x10^-4 * [Dosage] * [Process Flow], units as follows:

[Demand Flow, Active Chemical] = [lbs/hr]
[Dosage] = [mg/l]
[Process Flow] = [gpm]

Calculate the active chemical pump capacity at 100% as follows:

[Pump Capacity, Active Chemical] = [Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength/100]

[Pump Capacity, Active Chemical] = [lbs/hr]
[Volumetric Pump Capacity] = [gal/hr]
[Bulk Density] = [lbs/gal]

Calculate the pump speed as follows:

[Pump Speed] = 100 * [Demand Flow, Active Chemical]/[Pump Capacity, Active Chemical] = 10,000 * (5.007x10^-4 * [Dosage] * [Process Flow])/ ([Volumetric Pump Capacity] * [Bulk Density] * [Percent Bulk Strength])

[Pump Speed] = [%]

Example:

Ferric Chloride dosing with the following operator inputs/given values:

Dosage	[2 mg/l]
Volumetric Pump Capacity	[20 gal/hr]
Bulk Density	[11.93 lbs/gal]
Percent Bulk Strength	[40 %]
Process Flow	[3,000 gpm]

[Pump Speed] = 100 * [Demand Flow, Active Chemical]/[Pump Capacity, Active Chemical] = 10,000 * (5.007x10^-4 * [2 mg/l] * [3,000 gpm])/ ([20 gal/hr] * [11.93 lbs/gal] * [40])

[Pump Speed] = 3.15%

Preventing Nuisance Alarms

To prevent nuisance alarms, the PLC System Integrator shall provide PLC software time delays to alarm and control strategies during non-steady state conditions such as startup, loss of power and transitions.

REQUIRED GLOBAL FUNCTIONS

1. Calculate and display Elapsed Run Time of each pump or other piece of equipment whose ON status is displayed by the PICS System.
2. Calculate and display Cycle Counts of each pump or other piece of equipment whose ON status is displayed by the PICS System.
3. Trend each process variable that has a PLC analog input.
4. If shown under PICS discrete displays, derive HIGH-HIGH and LOW-LOW alarms from the associated process variable.
5. Totalize flow rate of each flow rate analog input.
6. Bumpless Transfer: For the PLC/PICS System, configure all “software” Manual/Auto switches so they provide “bumpless transfer.”
    a. Manual to Auto Transition: Once the transition occurs, immediately run the device if the Auto Mode so commands.
    b. Auto to Manual Transition:
        1) If a device has been running in Auto, configure so it continues to run once placed in Manual.
        2) If a device has not been running in Auto, configure so it does not run once placed in Manual.
        3) If an adjustable speed device has been running at a certain speed in Auto, configure so it runs at the same speed once placed in Manual.

MODULAR FUNCTIONS (Implement if noted in the specific unit process loop specifications)

MODULAR FUNCTION: CHEMICAL FEED PUMP

(Note: Prior to developing applications software, determine whether the submitted chemical feed pump provides two analog outputs (one for stroke speed, one for stroke position). It is possible the submitted pump will provide only one analog output proportional to total pump output. Adjust Modular Function accordingly.)

PICS Discrete Displays

ON Status.

Pump Run Fail Alarm.

Pump Drive Fail Alarm.

Pump High Discharge Pressure (if provided).

Pump Hose Leak Detected (if provided).

Pump under PICS Control (Field Hand Switch in Remote or Auto).

PICS Value Displays

Drive Speed.

Stroke Position.

Elapsed Run Time, display last 24 hours; see Global Functions.

Cycle Counter, display last 24 hours; see Global Functions.

Pump Revolution Counter (if provided).

PICS Trends

See Global Functions.

PICS Display and Control Functions

MANUAL/OFF/AUTO control.

- In MANUAL, provide Start/Stop control, manual speed adjust, and manual stroke adjust.
- In AUTO, provide control as per the specific Unit Process Loop Specifications.

By manual entry, input pump calibration factor (typically, a field observed gph at a given pump speed and a given pump stroke position).

By manual entry, input concentration of active substance (in percent)

Calculate pump output in engineering units based on the pump calibration factor, pump speed and pump stroke position, as follows:

- In volume units of bulk substance; e.g., 100 gph.
- In mass units of active substance; e.g., 13 pph of iron.

Modular Function: RUN Command/Speed Adjust

PICS Discrete Display

ON Status.

Pump/Equipment Run Fail.

Pump/Equipment under PICS Control (Field/MCC/VFD Hand Switch – if provided – in Remote or Auto).

Pump/Equipment Local Disconnect Open (if provided).

Enable/Disable Status (if provided).

PICS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions.

Cycle Counter; display last 24 hours; see Global Functions.

Pump Speed.

PICS Display and Control Functions

Provide MANUAL/OFF/AUTO control at Pump.

- In MANUAL, provide Start/Stop control and manual speed adjust.
- In AUTO, provide control and speed adjust as per individual Unit Process Loop Specifications.

Enable the above control only if the Pump is under PICS control.

Also, enable Pump Run Fail only if the Pump is under PICS control.

UNIT PROCESSES

Unit Process: Aluminum Chlorohydrate Storage and Feed System

A PICS provided Chemical Fill Panel (210FP) will receive the 4-20 mA level signal from the ultrasonic transmitter on the tank and retransmit the signal and a high level alarm to the PICS.

Modular Function: Field Alarm, 210LT, High Level, ACH Storage Tank.

Modular Function: Level, 2101LT, ACH Storage Tank.

Modular Function: Field Alarm, 210LS, Leak, ACH Storage Tank Lining

Modular Function: Run Command/Speed Adjust, 211P, ACH Feed Pumps.

In AUTO, modular function, Flow Pacing.

Process Flow: See Below.

Dosage Set Point: Manual Entry.

Control Element: ACH Pump Speed.

The ACH System provides a single dosage point to the splitter box.

The Process Flows used for dosing will now be as follows:

1. WB Casey Effluent Flow: 805FIT (existing)

    a. This signal shall be received via radio from PLC-1A at the Land Management Building.

Modular Function: Field Alarm, 212FSH, ACH Storage Area Safety Eyewash.

END OF LOOP DESCRIPTIONS

COMPONENT SPECIFICATIONS

A. Y555 PLC/RIO (Including Ancillaries):

1. General:
   a. Function: Multiloop analog and discrete control.
   b. Type:
      1) Programmable Logic Controller (or Remote I/O Drop).
      2) Fully isolated analog input and output modules.
      3) 10 BaseT Ethernet communication between PLC and Plant Control System.
   c. Parts: PLC Processor (or Remote I/O Drop), I/O Chassis, Power Supply Cabling, I/O Modules, Communication Interface Modules (CIM), and specialty modules.
2. Service:
   a. Operating Shock: 30g peak acceleration for 11 ms duration.
   b. Vibration: 2.0 g maximum peak acceleration between 10- to 500-Hz.
   c. Environmental:
      1) Operating Temperature: 32 to 140 degrees F.
      2) Relative Humidity: 5 to 95 percent (without condensation).
3. Type: PLC Processor, unless otherwise noted.
   a. If PLC Processor noted, 1.5 M RAM, unless otherwise noted.
4. PLC Processor:
   a. Features:
      1) Symbolic Addressing (IEC 1131-3 compliant).
      2) Ladder and function block diagram programming languages.
      3) Multiple processors can share common input data.
      4) Pre-emptive multitasking operating system.
      5) Advanced instruction set including file handling, sequencer, diagnostic, shift register, program control, ASCII, function blocks, and motion control instructions.
      6) Scheduled I/O data transfers.
      7) 128,000 I/O max in any mix (4,000 analog I/O max).
      8) Supports both Local I/O and Universal remote I/O.
      9) Supports DeviceNet, ControlNet, and Ethernet/IP communications.
   b. Memory: Battery-backed static RAM.
   c. Program Scan Time/K Instructions: 0.08 ms (Boolean).
   d. ControlNet I/O Scan Time/Chassis: 0.5 ms (typ).
5. I/O Chassis:
   a. Provide at least four spare slots.
   b. Provide slot filter for each unused slot.
   c. Provide all interconnect cable between chassis.
6. Power Supply Modules: Quantity and type as required to power all modules.

7. I/O Modules:
    a. Provide I/O modules to meet the functional requirements. Provide at least 20 percent spare I/O points per each I/O Type: DI, DO, AI, AO.
    b. Removable Terminal Blocks for each module.
    c. Unless otherwise noted, provide modules of the following type:
        1) Discrete Input Modules:
            a) General-purpose individually isolated 120V ac.
            b) 16 points maximum.
        2) Discrete Output Modules:
            a) Individually isolated contacts.
            b) NO.
            c) 16 points, maximum.
        3) Analog Input Modules:
            a) 4 to 20 mA dc.
            b) Isolated inputs.
            c) 25 ms min, 16-bit floating point resolution.
            d) “IF6I” Module.
        4) Analog Output Modules:
            a) 4 to 20 mA dc.
            b) Isolated outputs.
            c) 25 ms, min, 13-bit resolution.
8. Communications Interface Modules (CIM), unless otherwise noted, provide the following CIM and all needed software:
    a. Ethernet Module (ENBT):
        1) Communication Rate: 10 Mbps.
        2) Single-port.
        3) Quantity: One, unless otherwise noted.
9. Specialty Modules:
    a. Fiber Optic Communication Modules.
        1) Fault tolerant, self-healing ring.
        2) Communicates up to 16 miles with multimode fiber.
        3) Backplane Ethernet Connectivity.
        4) Manufacturer and Product: Phoenix Digital Fiber Optic Communication Module.
        5) Quantity: One, unless otherwise noted.
10. Programming Software:
    a. Processor, CIM, and I/O Modules:
        1) Ladder diagram and function block diagram.
        2) Supports the Following Processors: MicroLogix, CompactLogix and MicroLogix.
        3) Product: RS Logix Professional.
        4) Quantity: One total for Contract.
11. Manufacturer and Product: Allen Bradley MicroLogix 1400 with Ethernet connection.

PLC INPUT/OUTPUT LISTS								
PLC	**Dwg**	**Tag No.**	**Function/Description**	**DI**	**DO**	**AI**	**AO**	**Remarks**
210RTU	08-N-001	210LAHH	HIGH LEVEL, ACH STORAGE TANK	1				
210RTU	08-N-001	210LI	LEVEL INDICATION, ACH STORAGE TANK			1		
210RTU	08-N-001	210LS	LEAK ALARM, ACH STORAGE TANK	1				
210RTU	08-N-001	211P ~RK	RUN COMMAND, ACH FEED PUMP		1			
210RTU	08-N-001	211P ~IA	IN AUTO, ACH FEED PUMP	1				
210RTU	08-N-001	211P ~YS	RUN STATUS, ACH FEED PUMP	1				
210RTU	08-N-001	211P ~FA	FAIL ALARM, ACH FEED PUMP	1				
210RTU	08-N-001	211P ~PSH	HIGH DISCHARGE PRESSURE, ACH FEED PUMP	1				
210RTU	08-N-001	211P ~SI	SPEED INDICATION, ACH FEED PUMP			1		
210RTU	08-N-001	211P ~SK	SPEED COMMAND ACH FEED PUMP				1	
210RTU	08-N-001	212FAH	EYEWASH IN USE, ACH FEED SYSTEM AREA	1				
			210RTU TOTALS	**7**	**1**	**2**	**1**	

JACOBS **INSTRUMENT CALIBRATION SHEET** Rev.06.05.92

COMPONENT	MANUFACTURER	PROJECT
Code:	Name:	Number:
Name:	Model:	Name:
	Serial #:	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
Record? Y / N	Scale:				SWITCH? Y / N Unit Range:
Transmit/	Input:				Differential: fixed/adjustable
Convert? Y / N	Output:				Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
			Increasing Input		Decreasing Input	
Input	Indicated	Output	Indicated	Output	Indicated	Output
CONTROL MODE SETTINGS:			P:	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		**Note No.**
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	
1.					
2.					
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**

Component Calibrated and Ready for Startup

By:

Date:

Tag No.:

JACOBS

INSTRUMENT CALIBRATION SHEET

Rev.06.05.92

EXAMPLE - ANALYZER/TRANSMITTER

COMPONENT	MANUFACTURER	PROJECT
Code: *A7*	Name: *Leeds & Northrup*	Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Name: *UOSA AWT PHASE 3*
	Serial #: *11553322*	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
			Increasing Input		Decreasing Input	
Input	Indicated	Output	Indicated	Output	Indicated	Output
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		
Number	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	**Note No.**
1.	*N.A.*		*N.A.*		
2.					*1.*
3.					
4.					
5.					
6.					
7.					

#	**NOTES:**
	1. Need to recheck low pH calibration solutions.

Component Calibrated and Ready for Startup

By: *J.D. Sewell*

Date: *Jun-6-92*

Tag No.: AIT-12-6[pH]

JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

PARTS	Project Name:	Project Number:
Body	Type:	Mfr:
	Size:	Model:
	Line Connection:	Serial #:
Operator	Type:	Mfr:
	Action:	Model:
	Travel:	Serial #:
Positioner	Input Signal:	Mfr:
	Action:	Model:
	Cam:	Serial #:
Pilot	Action:	Mfr:
Solenoid	Rating:	Model:
		Serial #:
I/P	Input:	Mfr:
Converter	Output:	Model:
	Action:	Serial #:
Position	Settings:	Mfr:
Switch	Contacts:	Model:
		Serial #:
Power	Type:	Air Set Mfr:
Supply	Potential:	Model:
		Serial #:

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					

REMARKS:	**Valve Ready for Startup**
	By:
	Date:
	Tag No.:

JACOBS **I&C VALVE ADJUSTMENT SHEET** Rev.06.05.92

EXAMPLE

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear - Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot Solenoid	Action:	Mfr:
	Rating: *None*	Model:
		Serial #:
I/P Converter	Input: *4-20 mA dc*	Mfr: *Taylor*
	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position Switch	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power Supply	Type: *Pneumatic*	Air Set Mfr: *Air Products*
	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Startup**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** ***Rev.06.05.92***

Project Name:	Project No.:
Demonstration Test(s): For each functional requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.	

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

JACOBS **PERFORMANCE ACCEPTANCE TEST SHEET** **Rev.06.05.92**

EXAMPLE

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration Test(s): For each functional requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1. *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Acceptance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B.deGlanville*	*Jun-6-92*	Loop No.: *30-12*

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
   a. D638, Test Method for Tensile Properties of Plastics.
   b. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.
   c. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   d. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   e. D833, Standard Definitions of Terms Relating to Plastics.
   f. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
   g. D1525, Test Method for Vicat Softening Temperature of Plastics.
   h. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   i. D1998, Specification for Polyethylene Upright Storage Tanks.
   j. F412, Standard Terminology Relating to Plastic Piping Systems
3. ANSI Standards: B-16.5, Pipe Flanges and Flanged Fittings.
4. International Building Code.

1.02 DEFINITIONS

A. XLHDPE: Cross-linked high-density polyethylene.

1.03 DESIGN REQUIREMENTS

A. Tank to be double walled.

B. Manufacturer shall design bulk chemical storage tanks, including wall thickness and methods and locations of support and anchorage. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.
   b. Detailed fabrication drawings shall be scale drawings showing the size, configuration, pressure rating, materials of construction, and details of all equipment and materials to be furnished. Both plan and elevation views shall be provided. All tank nozzles shall be clearly shown, detailed, and fully dimensioned. Location and details of tank mounted supports to be provided.
   c. Resin used for each tank and all supporting specifications for resins.
   d. Foundation and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank foundations including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.
   e. Complete design calculations for tanks, supports and appropriate accessories. Diagrams and calculations shall be provided that indicate all static and dynamic loads. Reactions (uplift, shear, gravity loads) shall be indicated for each of the applicable loading combinations Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.
   f. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
   g. Electrical heat tracing and foam insulation data sheets.

B. Informational Submittals:

1. Fabricator's Certificate of Compliance with fabrication requirements.
2. Certified copy of all factory test results. Provide a listing of procedures used in testing.
3. Field test results
4. Manufacturer's Certificate of Proper Installation in accordance with Section 01 61 00 Common Product Requirements.
5. Operation and Maintenance Data: As specified in Division 01, General Requirements. As well as:
   a. Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.

1.05 QUALITY ASSURANCE

A. Fabricator's Quality Assurance Supervisor: Minimum of 10 years' experience in the fabrication of polyethylene storage tanks of similar size and usage.

B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (such as, ISO9001).

C. Tanks to be manufactured from virgin materials.

1.06 DELIVERY, STORAGE, AND HANDLING

A. All materials fabricated to this specification must be packaged, crated, or protected in such manner so as to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.

B. In addition, prepare and protect tanks for shipment as follows:

1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.
3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.
4. Do not ship components or other pieces loose inside the tanks.
5. Load tanks with at least 2 inches clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.
6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.
7. Nozzles or other fittings shall not be used for lifting.

1.07 SPECIAL GUARANTEE

A. Tanks shall have a minimum 2-year guarantee from the tank manufacturer, covering the complete cost of repair and replacement of the tanks (not including any costs associated with altering, removing, or demolishing the existing facility structure for such removal which shall be borne by Contractor) during the first 2 years of service, should leakage occur through the tank or the tank fittings, or should the tank or tank fittings show signs of fatigue or failure as determined by Engineer.

PART 2 PRODUCTS

2.01 GENERAL

A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tanks and making external piping connections.

B. All equipment specified herein shall be suitable for contact with the stored chemical.

C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer's service.

D. Materials of Construction: Unless specifically noted otherwise, materials are to be one the following as they are compatible with the chemical:

1. PVC.
2. CPVC.
3. Hastelloy-C276.
4. PVDF.
5. PTFE.
6. Polyethylene/HDPE.

2.02 MANUFACTURERS

A. Poly Processing Company- SAFE-TANK®.

B. "Or-equal" Engineer approved.

2.03 SERVICE CONDITIONS

A. Location: Outdoors without cover.

B. Operating Pressure: Atmospheric.

C. Stored Materials: See attached tank Data sheet.

2.04 TANK DESIGN CRITERIA

A. Seismic/wind/snow/etc. Loads: See Design Criteria in Structural Notes General Drawing.

B. Special Loads: Design tanks for dead loads from all attached piping.

C. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.05 TANK CONSTRUCTION

A. Dual walled containment configuration.

B. Tanks specified herein shall be rotationally molded, cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and shall meet or exceed all requirements of ASTM D1998.

C. Tanks shall be vertical, flat bottom, dome top.

D. Tanks shall be fabricated to the dimensions shown in the Tank Data Sheet.

E. Resin shall contain ultraviolet stabilizer.

F. Materials shall meet or exceed the following properties:

Parameter	ASTM Test	Requirement
Density	D1505	0.944 - 0.946 gm/cc
Environmental Stress, Cracking Resistance (F50)	D1693	1,000 hrs
Tensile Strength, Ultimate (2" min.)	D638	2,600 - 3,000 psi
Elongation at Break (2" min.)	D638	400%
Vicat Softening Point	D1525	240 degrees F
Flexural Modulus	D790	100,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethylene Notch Test (PENT)	F1473	>1,000 hours

2.06 TANK SUPPORT AND RESTRAINT SYSTEM

A. Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.

B. Provide a minimum of four Hastelloy C holddown lugs, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank full.

2.07 FITTINGS

A. Tank fittings and openings shall be provided as shown in the attached tank data sheet.

B. Connections for piping shall be flanged (150 pound bolt pattern) and gasketed (PTFE gasket).

1. Connection for tank outlet (pump feed) to be a bellows transition fitting suitable for connection to dual-wall piping.

C. Bolted fittings shall use Hastelloy C bolts with polyethylene-encapsulated heads and PVC external flanges.

D. No wetted fittings or appurtenances shall be of metallic construction.

E. Vent at top of tank to include U-type gooseneck with insect screen.

2.08 ACCESSORIES AND APPURTENANCES

A. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.

B. Gaskets:

1. Made of PTFE, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.
2. Type: 1/4-inch thick, low torque, full face, ASME B16.1 dimensions.

C. Pipe Supports:

1. Provide pipe supports for the fill pipe and overflow pipe.
2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 feet on center.
3. Pipe supports shall allow removal of supported pipes.
4. Complete with Hastelloy C bolts, nuts, washers, and other necessary hardware for easy field assembly.

D. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds.

E. Anchor Bolts: Hastelloy C bolts, sized by fabricator and at least 3/4-inch diameter.

F. Heat tracing system for temperature maintenance shall be SilcoPad® tank heating systems designed to maintain a desired product temperature, not to exceed 100 degrees F. Each system shall include tank heating pads and a temperature controller. Tanks are supplied with the heating panels and a controller installed by Poly Processing Company. Power supply to be the only field installation required.

1. Pads to operate on 120V ac single phase with a maximum power density of 0.5 watts/sq inch.
2. Silicone pad heaters must fully comply with Article 427-23 (b) of the National Electric Code.
3. Temperature controller to be supplied with two electronic thermostats switching the heating system via one solid state relay. Primary thermostat to control desired product temperature and secondary thermostat to provide over temperature protection at 150 degrees F.

G. Insulation:

1. Insulation used shall be polyurethane foam with a density of 2.5 lb/ft^3 with a minimum an “R” value of 6.3 per inch. The foam shall be applied with a nominal thickness of 2 inches to the external tank surfaces except the tank bottom.
2. Upon completion of application and curing of the insulation, two full coverage coats of latex mastic coating shall be applied to the surface of the insulation in such manner as to seal the insulation from the outside environment.

H. Level instruments:

1. Ultrasonic Level Transmitter: The inner tank ultrasonic level transmitter shall be a Flowline ultrasonic level transmitter, level controller with one 4-20 mA or 0-10V dc continuous level input and NEMA 4X box to be supplied by tank manufacturer.
   a. The level transmitter shall be a 2-wire loop powered device.
2. Ultrasonic leak detection switch: Outer tank instrument to indicate when a leak has occurred.

2.09 SOURCE QUALITY CONTROL

A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.

B. Factory Tests:

1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTM D1998.

2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
3. Hydrostatic Leak Tests.
4. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
5. Fitting location verification.
6. Reports: Certify, by signature, the results of the factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with the manufacturer's written instructions.

B. Contractor shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.

C. Accurately place anchor bolts using templates furnished by the manufacturer or as otherwise recommended by manufacturer.

D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.

E. Uniform and level surface contact shall be made between all tank bottoms and the support foundations.

F. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tanks shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.
2. Quality control shall include a final inspection by Contractor and a written record of this final inspection.
3. After testing, the tanks shall be thoroughly cleaned and dried.

3.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the Job Site and classroom designated by Owner for the minimum person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for inspection, certification of the installation, and training.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this Specification.

1. Tank Data Sheet.

END OF SECTION

Jacobs

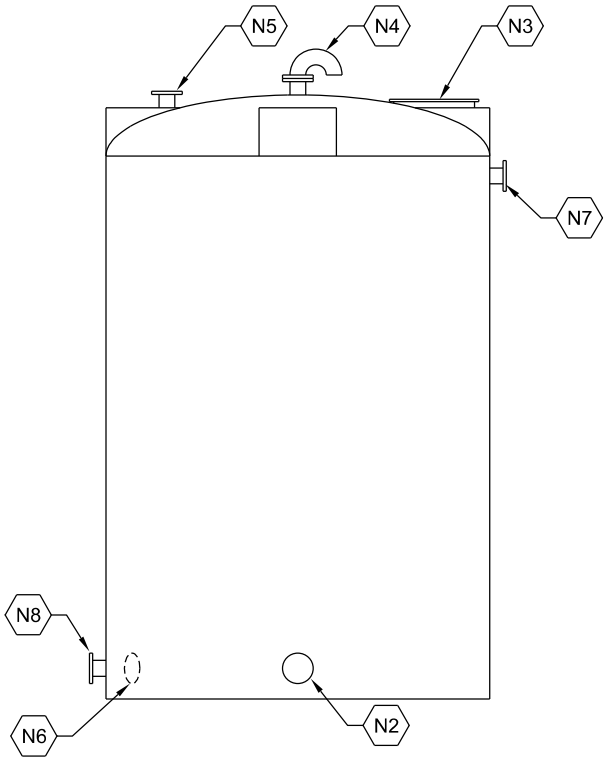
TANK DATA SHEET

HUIE WETLANDS CHEMICAL FEED
PROJECT NUMBER EEXJ6915

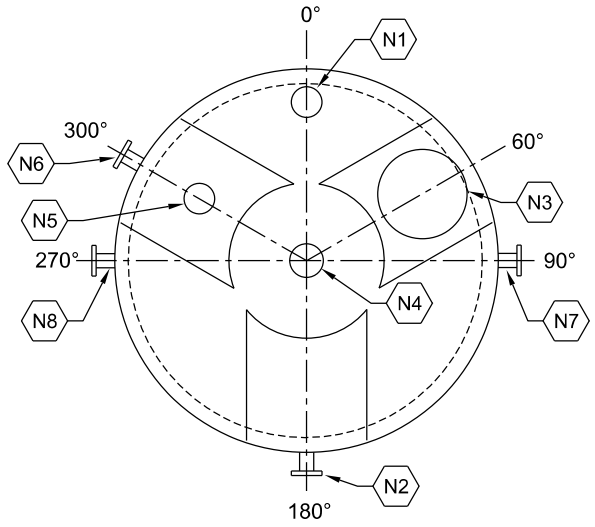
TANK NAME:	ACH STORAGE TANK		
TAG NUMBER(S):	210T		
SERVICE:	ALUMINUM CHLOROHYDRATE	INNER TANK OUTER DIAMETER:	9'-7"
CAPACITY:	4,400 GALLONS	ROOF TYPE:	DOMED
pH RANGE:	4-5	BOTTOM TYPE:	FLAT
SPECIFIC GRAVITY:	1.40	INNER TANK STRAIGHT SHELL HEIGHT:	8'-3" MIN

NOTES:

1. SEE CORRESPONDING SPECIFICATION SECTION FOR ADDITIONAL DETAILS.



COMPOSITE SECTION
NTS



PLAN
NTS

NOZZLES	MARK	SIZE/TYPE	CL ELEV	CL RADIUS	NOTES
FILL	N1	2"/STD	-	4'-6"	
PUMP FEED (OUT)	N2	2"/DWC	NOTES	-	AS LOW AS POSSIBLE
TOP MANWAY	N3	24"/-	-	NOTES	MANU. STANDARD
VENT	N4	3"/STD	-	0'-0"	
LEVEL INSTRUMENT	N5	NOTES	NOTES	NOTES	MANU. STANDARD
LEVEL INSTRUMENT	N6	NOTES	NOTES	NOTES	MANU. STANDARD
OVERFLOW	N7	3"/STD	NOTES	-	AS HIGH AS POSSIBLE
CONTAINMENT DRAIN	N8	2"/STD	NOTES	-	AS LOW AS POSSIBLE

SIZE: FOR DOUBLE WALL CONTAINMENT PIPE, THIS REPRESENTS THE INTERIOR CARRIER PIPE SIZE.
TYPE: STD-STANDARD CONNECTION, DWG-CONNECTION SUITABLE FOR DOUBLE WALL CONTAINMENT PIPE.
CL ELEV: DISTANCE FROM TOP OF TANK PAD TO CL OF NOZZLE.
CL RADIUS: DISTANCE FROM TANK CENTER TO CL OF NOZZLE.

DESIGN DATA
TANK LOCATION: OUTSIDE, NO COVER
HANDRAILS: NO
PLATFORM: NO
LADDER REQUIRED: NO
PIPE SUPPORTS FOR INTERIOR PIPING: NO
PIPE SUPPORTS FOR EXTERIOR PIPING: YES
HEAT TRACING: YES
INSULATION: YES
TIE DOWN SYSTEM: YES
SEE DESIGN CRITERIA ON STRUCTURAL NOTES DRAWING FOR LOADING REQUIREMENTS

SECTION 44 44 13.01
CHEMICAL METERING PUMPS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Hydraulic Institute Standards.
2. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data on pumps, including curves showing flow rate verses pump stroke setting (in percent) at specified maximum speed in strokes per minute and at minimum pump speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, and appurtenances to be provided with pumps.
   e. Detailed dimensional drawings for pump skid, including mounting requirements and piping connection sizes and locations.
   f. Power and control wiring diagrams, including terminals and numbers.
   g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
   h. Manufacturer's materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.
   i. Factory finish system.
   j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements
3. Test result reports
4. Operation and Maintenance Data: Division 01, General Requirements.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish a shelf spare of the pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

B. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

C. Materials of Construction: Unless specifically noted otherwise, materials are to be one of the following that is compatible with the intended chemical:

1. PVC.
2. CPVC.
3. Hastelloy-C276.
4. PVDF.
5. PTFE.
6. Polyethylene/HDPE.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 PUMP

A. Positive displacement self-compensating hydraulically activated diaphragm type. Diaphragm shall be PTFE, PTFE coated diaphragms are not acceptable.

B. Pump head shall be PVC with ceramic ball materials.

C. Wetted gasket material to be PTFE.

D. Head to include integral priming valve.

2.04 ENCLOSURE

A. Drive mechanical and microprocessor shall be housed in a corrosion resistant, plastic UV stabilized enclosure.

B. Pump Enclosure taking shall be to IP65 and NEMA 4X standards.

2.05 DRIVE

A. An integral variable speed stepper motor shall be used.

B. The drive mechanism shall not require regular field service or external lubrication.

C. The motor shall be integral, supplied with power cord and plug.

2.06 INTERFACE

A. User display shall be backlit lcd with selectable on-site positioning.

B. Shall provide a selection of metered output to be displayed in gallons per hour or liters per hour.

C. To include a turn and push knob for easy navigation.

D. To include built in counter to provide running total of accumulated strokes, cumulative hours of operation, and dosing flow.

E. Include priming button that initiates a time selectable prime cycle operating at full capacity without need of attenuating the pump output setpoint.

2.07 OPERATION

A. Repeatable metering accuracy shall be plus or minus 1 percent at constant hydraulic conditions throughout the entire output range.

B. Equipped with a slow mode function for use with high viscosity liquids.

C. Equipped with a calibration function which when initiated operates the pump for a set number of strokes and displays the anticipated pumped volume.

D. Equipped with an analog re-scalable 0/4-20 mA signal input. Scaling menu to allow for four point adjustments (two for signal, two for flow) within the signal and flow ranges.

E. Equipped with provisions for selectable mode NO/NC external pump enable/disable interface.

F. Equipped with input connection for dual level control and alarm outputs for low level and empty tank warnings.

G. Equipped with programmable proportional 0/4-20mA signal output.

H. Shall be able to automatically de-aerate the pump head without the need for external devices.

I. Equipped with two potential free selective programmable outputs.

2.08 CONTROL

A. The pump shall come equipped with two menu selectable control modes; Manual and analog.

1. Manual Control:
    a. Output of pump is displayed in gal or liters per hour. Pump output adjustment is performed with the turn and push knob (click wheel) on the interface.
    b. Pumping rate changes are to be achieved through precise speed control with fixed full stroke length.
    c. Pump should include a start/stop key.
2. Automatic Control:
    a. Analog: Pump shall include direct interface provisions for analog control. Both direct and reverse acting 0/4-20 mA input configurations are to be acceptable inputs. The menu configuration shall permit pump maximum output multipoint scaling. The pump shall include a local alarm for loss of input signal.

B. Drive unit shall include separate control panel with the following:

1. Speed indication in percent.
2. HAND/OFF/AUTO selector switch.
3. Manual adjustable potentiometer for adjustment of pump speed when in HAND position.
4. Pump On Indication.
5. Pump Fault Indication.
6. Reset Pushbutton.

7. Drive shall receive/accept the following external signals:
    a. Discrete Inputs:
        1) Start Command.
        2) High Pressure.
            a) Stop pump upon high pressure.
    b. Discrete Outputs:
        1) Pump Running.
        2) Pump In Auto.
        3) Pump Fault.
        4) Pump High Discharge Pressure.
    c. Analog Inputs: 4-20 mA dc control signal to provide linear adjustment of pump speed from zero to 100 percent when in AUTO position.
    d. Analog Outputs: 4-20 mA analog output signal for drive speed.
8. Manufacturer supplied power cable from the control panel to the pump.

2.09 ACCESSORIES

A. Polypropylene skid, factory assembled with the pump, control panel, 0.5-inch schedule 80 PVC piping, and the following accessories (sized by manufacturer based on pump capabilities):

1. PVC ball valves with union ends. Provide at a minimum of the following locations:
    a. At skid inlet and outlet.
    b. Inlet of calibration column, vent connection for calibration column, and to isolate calibration column from discharge pipe.
    c. Pump inlet and outlet.
    d. Discharge piping drain valve.
2. PVC Y strainer on inlet piping.
3. Pressure relief valve.
4. Backpressure valve.
5. Pressure gauge, high pressure switch, pressure diaphragm element assembly.
6. Calibration column with 0.05 gallon graduations.
7. Skid to have drain tap with 0.5-inch PVC stub out on the right side of the skid (when facing it), placed as far towards the back board as possible.

B. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications.

2.10 SOURCE QUALITY CONTROL

A. Manufacturer standard factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Test:

1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

C. Performance Test:

1. Perform under actual or approved simulated operating conditions.
2. Test for a continuous 3-hour period without malfunction.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-days for installation assistance and inspection.
2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1 person-day for classroom or Site training.

B. See Section 01 43 33, Manufacturers' Field Services.

3.04 SUPPLEMENTS

A. Supplement listed below, following "End of Section," are part of this Specification.

1. Data Sheet: Pump and Motor.

END OF SECTION

CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01

Tag Numbers**:** 211P

Pump Name: ACH Feed Pump

Manufacturer and Model Number: (1) Grundfos DDA 30-4
(2) No "Or-equal"

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Aluminum Chlorohydrate

Liquid pH: 4-5

Specific Gravity: 1.40

PERFORMANCE REQUIREMENTS

Capacity (US gpm):

Maximum: 8 GPH

Minimum: 0.18 GPH

Maximum Discharge Pressure (psig): 58

DRIVE MOTOR

Drive motor is manufacturer's standard and integral with pump

Power: 30 Watts Voltage: 120 Phase: 1

REMARKS

DRAWINGS

(BOUND SEPARATELY)